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NORTH CAROLINA NATURAL HERITAGE PROGRAM BIENNIAL PROTECTION PLAN

1993

Division of Parks and Recreation
Department of Environment, Health and Natural Resources

NORTH CAROLINA
NATURAL HERITAGE PROGRAM
BIENNIAL PROTECTION PLAN

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Division of Parks and Recreation
Department of Environment, Health and Natural Resources

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INTRODUCTION

From the cool, windswept slopes of the ancient Appalachians to the sparkling necklace of barrier islands adorning the sea, the natural resources of North Carolina are a source of great pride and enjoyment to her people. These natural resources are a heritage to be treasured and passed down through the generations.

North Carolinians have expressed in many ways their desire to preserve and protect this natural heritage. The North Carolina Constitution directs the State to preserve its forests, wetlands, estuaries, beaches and places of beauty. State lands are acquired and managed to protect forests and natural areas, to preserve wildlife habitat, and to provide opportunities for outdoor recreation and education. State and federal laws have been passed to protect endangered and threatened species of plants and animals. North Carolinians want to protect rare species and to preserve examples of the state's outstanding natural heritage.

We also want to enjoy economic growth and prosperity, but we know that development can damage the natural resources that we value so highly. To accomplish these two public goals of preservation and development, we must conscientiously strive to make our land use decisions with careful knowledge of the results of our actions. Good information can help us avoid unnecessary, unintentional, or thoughtless damage to our natural heritage.

Which of the state's many species and natural communities are so rare that they need special protection? Where are these species and communities located, and what kind of environment do they need to survive? With limited resources for public acquisition of natural lands, which areas have the greatest ecological significance? Which are the most vulnerable to damage and loss? Are we preserving examples of the full range of North Carolina's natural diversity for future generations to enjoy and study? We need to know these things in order to weigh the costs and benefits of our actions and to make the best choices.

The North Carolina Natural Heritage Program was established to help provide answers to these questions. Staffed by some of the state's best biologists, the Natural Heritage Program conducts and supervises systematic field surveys of the state's natural environments to identify important natural areas and to determine the relative rarity of species and natural communities. The resulting information is compiled, mapped, and made available to landowners, planners, policy-makers, educators, and government agencies. The Natural Heritage Program also provides management and protection assistance to landowners to enable them to protect important natural areas on their land.

THE NATURAL HERITAGE PROGRAM

The activities of the Natural Heritage Program fall into three broad categories: Inventory, Information Services, and Protection Planning. Inventory is the collection of information about the occurrences and distribution of the rarest plants and animals and the highest-quality natural communities of the state. This information is stored in the Natural Heritage Biological and Conservation Database. Information Services provide a variety of landowners, agencies, corporations, and scientists with information they need for effective planning, research, and protection efforts. Protection Planning uses the information in the database to assist and encourage landowners in the protection of these important natural resources.

INVENTORY

North Carolina is home to approximately 5,700 species of plants, 935 species of vertebrate animals, and nearly 15,000 species of freshwater and terrestrial invertebrates. Many more invertebrates inhabit estuarine and marine areas. These constitute a major component of the natural diversity of our state. Faced with the daunting task of compiling information about so many elements of diversity, the program chose to focus on the collection of information about the locations or "occurrences" of the rarest species. A great deal of information is available in records of past biological studies in the state; but there are many areas which have never been fully explored, and many species whose life histories are very poorly known. An understanding of the status and relative rarity of the state's many species can only be gained through careful field work by expert biologists.

New inventory information comes primarily from two sources. The first is the network of academicians and private and agency biologists who share information collected through their own work and research. In return, the Natural Heritage Program shares its knowledge with these biologists to facilitate their research, planning, and protection efforts. The second source of inventory information is the field work conducted or supervised by the Natural Heritage Program's own biologists. Their work is often funded through contracts or grants, or results from the cooperative efforts of the Natural Heritage Program and a variety of agencies. These field studies can be directed toward the most vulnerable species and to areas where information is most urgently needed. In addition, by conducting or supervising the work, program staff can ensure quality and consistency in methodology and results.

In addition to information about rare plants and animals, the Natural Heritage Program collects information about critical components of habitat, significant geologic features, and other special features, such as colonial bird nesting sites. The Natural Heritage Program also collects information about the natural communities of the state. The Natural Heritage Program has developed a classification of North Carolina's natural communities to assist field biologists in their work and to improve the comparability of their results. This classification, currently in its third edition, describes 116 natural community types ranging from the grassy balds in the mountains to the maritime forests of the barrier islands. The North Carolina classification has served as a model for classifications in other states and in the Southeast region.

The Natural Heritage Program sponsors an ongoing series of county inventories. The long term goal is to complete an inventory for every county in North Carolina. The inventories will identify the location of rare plants and animals, undisturbed natural communities, and important natural areas worthy of protection. Conducted by professional biologists, these inventories may be funded variously by local governments, private citizens, or corporate contributors. In recent years, a major source of funding has been the state's Recreation and Natural Heritage Trust Fund. The inventory biologists are often under contract to the Natural Heritage Program. If not, they are at least assisted and coordinated by program staff. Several county inventories have been completed, several others are currently underway, and still others are to be initiated soon.

All of the information collected in the inventory work is compiled in the Natural Heritage Program's Biological and Conservation Database. Both computerized and manual, this database is a dynamic atlas that includes ecological and location information about rare species, natural communities and special features. The database follows a methodology which was developed by The Nature Conservancy and which is currently in use in 85 similar programs in the United States, Canada, and Central and South America. The North Carolina Natural Heritage Program is one of the oldest members of this international network. With 12,000 records of element locations in North Carolina, its database is one of the most extensive.

By the end of 1992, nearly 12,000 records describing the occurrences of 1,028 different elements (rare species, natural communities, and special features) were contained in the program database. These records are continuously updated as the status and condition of the occurrences are monitored. Thus, the database can never be considered complete. The natural landscape is forever changing, and with new data being continually collected and interpreted, the database is dynamic and always improving in terms of both accuracy and completeness. As the inventory work progresses, the results and products of the program's work become more accurate and more useful.

INFORMATION SERVICES

As environmental awareness has grown in North Carolina, so has the use of the Natural Heritage Program data. The program actively encourages this use of the state-funded database by the public. Each year, program staff respond to several thousand written and telephone requests for biological information.

One of the most important uses of the Natural Heritage Program database is to provide information as early as possible during the planning of a project. This allows locations of rare species and natural areas to be taken into account and, when possible, avoided or accommodated. Program staff review plans for roads and bridges, airports, wastewater treatment plants, sewer lines, timber sales, coastal dredging, and many other public and private construction and development projects. The inventory database is searched to identify locations of rare species and priority natural areas which might be affected by proposed projects. The project sponsor is made aware of the presence of rare species and communities, so that efforts can be made to eliminate or reduce any negative effects.

Another major use of the database is to assist state and federal agencies which administer regulations to protect endangered species. The U.S. Fish and Wildlife Service administers the federal Endangered Species Act, which lists and provides legal protection for plant and animal species which are Endangered or Threatened. The N.C. Endangered and Threatened Wildlife Act, administered by the Nongame and Endangered Wildlife Program of the N.C. Wildlife Resources Commission, protects animal species listed as Endangered, Threatened, or Special Concern at the state level. The Plant Conservation Program of the N.C. Department of Agriculture administers the Plant Protection and Conservation Act, which lists and protects rare plant species. All of these agencies use the information in the Natural Heritage Program database to help them determine which species are so rare that they need legal protection, where populations of rare species are located, and what types of regulations are needed to protect them.

Public and private landowners often request biological information to assist them in protecting and managing rare species or significant natural areas on their land. Several federal land-holding agencies have compatible Biological and Conservation Databases, so that information can be exchanged by computer. Information from the Natural Heritage Program database is also invaluable to scientific researchers studying the elements of natural diversity. The Natural Heritage Program also receives numerous information requests from students. These requests range from elementary schoolchildren looking for general information on the state's natural diversity to graduate students seeking help with thesis or dissertation research. Finally, private citizens contact the Natural Heritage Program to get information about interesting species and natural areas of their locale, information about establishing local land trusts, and advice for initiating county-wide natural area inventories.

PROTECTION PLANNING

In the ongoing inventory of the state's natural resources, more than 1,200 natural areas of national, state, or regional significance have been identified by the Natural Heritage Program. These range in size from just a few acres to many hundreds of acres. Additional important natural areas are being discovered each year. These, as well as other areas containing rare species, are the areas which most need protection from damage and alteration to ensure that future generations can enjoy the rich biological diversity of North Carolina.

Significant natural areas occur on both public land and private land. An important function of the Natural Heritage Program is to assist the landowner with appropriate protection measures. The most important step is to inform the landowner of the high ecological value of the site, and to provide useful information on the protection and management needs of the plants and animals on the site.

Several other protection options are available. For example, the Natural Heritage Program maintains the North Carolina Registry of Natural Heritage Areas, a prestigious list of some of the state's most ecologically significant sites whose owners have agreed to protect and manage them to retain their natural heritage values. Landowners who place their land in the Registry are making a voluntary, non-binding commitment to preserve the natural area. For each registered area, an agreement is written in cooperation with the landowner. This agreement describes the ways the landowner and the Natural Heritage Program will work together to protect the biological diversity of the natural area. Because it is not a legally binding document, the agreement can be cancelled at any time, although the Natural Heritage Program appreciates 30 days written notice. Three hundred and eleven natural areas across the state are currently listed on the Registry of Natural Heritage Areas. Federal and state agencies, local governments, large land-holding corporations, universities, conservation organizations, and small private landowners have placed their properties on the Registry.

Landowners of important natural areas who wish to pursue more permanent protection may choose to dedicate their property as a state nature preserve. Dedication transfers some degree of property interest to the state, and permanently limits uses of the property so as to preserve its natural values. The terms of the dedication are negotiated between the landowner and the state. Landowners who offer to dedicate their property at less than market value may receive certain tax benefits.

Some landowners may wish to preserve their significant natural areas permanently, but cannot afford to donate a property interest to the state. In these cases, public acquisition of the site may be appropriate. The Natural Heritage Program itself does not acquire land, but it provides natural area information to public conservation landholders such as the State Parks System, the National Park Service, and the Wildlife Resources Commission, and to private conservation organizations such as The Nature Conservancy and the Triangle Land Conservancy. The agencies use this information to help make decisions on acquisition priorities.

Many significant natural areas require active management to allow the rare species and communities they harbor to persist. The Natural Heritage Program tries to remain involved with the owner of each significant site, whether or not the owner chooses to register or dedicate the site, in order to provide the owner with management advice and assistance. For example, longleaf pine savannas, once kept open by frequent lightning fires, now need prescribed burning to reduce shrub invasion and to stimulate growth and reproduction of diverse grasses and wildflowers. Mountain bogs may need special measures to prevent them from drying out or being invaded by shrubs. Natural Heritage Program staff work closely with landowners to ensure that natural areas are successfully managed.

THE BIENNIAL PROTECTION PLAN

The Natural Heritage Program Biennial Protection Plan is prepared every two years to inform the Governor, the General Assembly, and the public of program activities planned for the upcoming biennium. The plan is presented in three sections: Plants and Animals, Natural Communities, and Landscapes.

PLANTS AND ANIMALS

The Natural Heritage Program inventories and monitors the location and status of rare plant and animal species throughout North Carolina. Species may be rare because they live in a habitat which is rare or unusual, or they may be rare because their populations have been greatly reduced as a result of human activity. The Biennial Protection Plan presents a brief summary of the status of the major groups of species.

NATURAL COMMUNITIES

Plant and animal species live together in natural communities, which vary in appearance and composition depending on soil type, moisture, temperature, and other physical factors. The Natural Heritage Program inventories and monitors natural community types as distinctive elements of biological diversity. The Biennial Protection Plan groups these community types into themes, and discusses the goals, protection needs, and management issues of each theme.

LANDSCAPES

Natural communities occur in complex mosaics across the landscape. Inventory and protection efforts often are directed toward landscapes containing a combination of different species and community types. The Natural Heritage Program often conducts inventories on a regional basis, for multi-county areas, and for national forests, military bases and other large federal landholdings. The Biennial Protection Plan presents a brief summary of landscape level efforts.

An appendix to the Biennial Protection Plan lists the most significant natural areas known in North Carolina. The list includes approximately 1200 sites. The appendix is published in a separate volume, which is available on request.

ADDITIONAL PUBLICATIONS

Detailed information on the status of individual plant and animal species and descriptions of each natural community type can be found in these related publications.

Natural Heritage Program List of the Rare Plant Species of North Carolina, compiled by Alan S. Weakley. $5.00

Natural Heritage Program List of the Rare Animal Species of North Carolina, compiled by Harry E. LeGrand, Jr. $5.00

Classification of the Natural Communities of North Carolina (Third Approximation), by Michael P. Schafale and Alan S. Weakley. $15.00

To obtain copies, please contact the Natural Heritage Program, Division of Parks and Recreation, P.O. Box 27687, Raleigh, N.C. 27611, (919) 733-7701. Prices reflect the costs of production and are subject to change.

PLANTS AND ANIMALS

North Carolina's flora and fauna are rich and varied. This diversity of species is the result of North Carolina's diversity of elevation, climate, soils, and geology. Occurring in North Carolina are the typical and characteristic species of the southeastern North American Coastal Plain, Piedmont, and Mountains. In addition, North Carolina's plants and animals include species adapted to unusual habitats. Many of these species are rare, occurring in few places and in small numbers. Some species are naturally rare because their habitats are in some way naturally limited or specialized. Others are rare because of the effects of human activities.

Natural rarity is usually because the suitable habitat for a species is very specialized or severely limited in area or distribution. North Carolina is geologically diverse, and the soils that weather from different rock types support different plant and animal species. Unusual soil types often support unusual plant and animal species. For example, a serpentine barren in Clay County supports numerous rare species, including several found nowhere else in the state. Calcareous pine savannas in Pender, Onslow, Brunswick, and Columbus counties support numerous rare species not found in the more typical savannas with acidic soils.

Climate is also responsible for pockets of rare plants and animals which require special temperature and moisture regimes. Several dozen rare plants and animals are limited to the higher elevation peaks of the Southern Appalachians, the highest mountains in North America east of the Mississippi River, where conditions resemble those found in boreal areas far to the north. Some of these species are remnants of the tundra environment that existed in North Carolina's mountains during the Pleistocene, 15,000 years ago. In Transylvania, Jackson, and Macon counties, the escarpment gorges of the Toxaway, Horsepasture, Thompson, Whitewater, and Chattooga rivers receive more rainfall than any area of North America east of western Washington and Oregon. Constantly moist conditions in the fine spray of numerous waterfalls support relicts of long-past floras, including tropical mosses, liverworts, and ferns. A number of subtropical species, including palms, live in the maritime climate of North Carolina's barrier islands.

Some species which would not be considered naturally rare have become rare because of human activities. For example, longleaf pine, valued for its timber, pitch, rosin, and turpentine, was the cornerstone of North Carolina's economy for much of the state's history. Longleaf pine is now reduced to less than a tenth of its former abundance in the state, and many of the plant and animal species which relied on this formerly widespread habitat are now rare.

Direct exploitation of economically valuable species is only part of the problem, however. The single most important factor affecting North Carolina's native flora and fauna is the loss of habitat resulting from conversion of land to uses which do not support native species, or which greatly reduce their diversity and numbers. Land devoted to agriculture, intensive silviculture, road corridors, cities, towns, and suburbs now makes up well over half of North Carolina's landscape. Some of the remaining land has also been severely altered by erosion, drainage of wetlands, or contamination by pollutants.

Many other human activities have affected natural habitats and the species which depend on them. Suppression of natural, lightning-set fires that once swept across much of North Carolina's landscape has led to declines in many species adapted to fire-maintained ecosystems. Non-native species introduced either intentionally or accidentally, such as Japanese honeysuckle, privet, kudzu, starlings, and gypsy moths, can outcompete less aggressive native species. Introduced pests have devastated once economically and ecologically dominant trees, such as American chestnut and Fraser fir.

Whatever the cause of their rarity, rare species are vulnerable to being extirpated from North Carolina, or in some cases throughout their ranges, simply because they are rare. The Natural Heritage Program inventories, monitors and encourages protection of the rarest and most vulnerable species, generally defined as those with fewer than 20 populations in the state or fewer than 50 rangewide. The program maintains a computer database and mapped records on all species listed by the U.S. Fish and Wildlife Service, the N.C. Wildlife Resources Commission, and the N.C. Plant Conservation Program. The program also monitors additional species whose status is not well known, and other species which are known to be rare but which have not yet been officially listed.

PLANTS

FLOWERING PLANTS

Flowering plants cover most of the Earth's terrestrial landscape, and they include the great majority of plants familiar to the public. Examples include oaks, pines, grasses, orchids, lilies, mayapples, roses, asters, goldenrods, and trilliums. There are approximately 4180 species of flowering plants in North Carolina.

Flowering plants are the best known group of plants; but many species, especially those which are rare, are not well known. Even now, after centuries of botanical investigation, biologists from the Natural Heritage Program and other agencies and universities are each year discovering in North Carolina dozens of species not previously reported to occur in the state. For most rare species, even those which are well studied taxonomically and whose numbers and distribution are well known, little is known of the species' biology, ecological requirements, or management needs.

During the next two years, the Natural Heritage Program will conduct status surveys on at least five federal candidate species, to determine if federal listing as Endangered or Threatened is warranted. Recovery plans will be completed for two species. County and regional inventories will result in new records of the location and status of rare flowering plants.

FERNS AND FERN ALLIES

Ferns and "fern allies" (spikemosses, clubmosses, whiskferns, quillworts, and horsetails) are non-flowering plants with vascular tissues. They evolved before flowering plants and dominated Earth's vegetation during the Age of Dinosaurs and before, forming the primary coal beds which are mined today. Of the 108 species of ferns and fern allies in North Carolina, many are on the state or federal lists of Endangered or Threatened species. This high percentage is because most of the state's fern species occupy specialized and rare habitats. Filmy-ferns and other tropical species are limited to outcrops in the humid escarpment gorges. Carolina Spleenwort (Asplenium heteroresiliens) grows on rare outcrops of coquina limestone in southeastern North Carolina, South Carolina, Georgia, and Florida in fewer than two dozen places.

The Natural Heritage Program is planning no specific studies of rare ferns and fern allies during the next two years. General inventories around the state will include ferns.

MOSSES, LIVERWORTS, AND HORNWORTS

Mosses, liverworts, and hornworts, collectively known as bryophytes, are small plants which lack vascular tissue and reproduce by spores. In North Carolina, they reach their greatest diversity in humid parts of the mountains, especially on high mountain peaks and in the moist escarpment gorges, which feature numerous rare species. Lacking vascular tissue, bryophytes live in closer contact with soil, rock, and air than do flowering plants, ferns, and fern allies. They are thus more sensitive indicators of unusual environmental conditions. Because they are small and require magnification for their identification and appreciation, fewer scientists have studied bryophytes than flowering plants, and they are more poorly known. Only recently have bryophytes been placed on federal and state lists of Endangered and Threatened plants. Much additional study is needed in order to fully understand the rarity status of many species.

During the next two years, an inventory of 25 federal candidate bryophytes will be conducted. This study will contribute to a basic understanding of this little known group.

LICHENS

Lichens are actually dual or partner organisms, consisting of a paired combination of a fungus and an alga. Lichens have become famous for their sensitivity to air pollution, and are often used as "biomonitors" in studies of air pollution patterns. Lichens produce characteristic and diverse chemical compounds, some of which are used in the dying of cloth or have shown considerable promise for medical research.

The Southern Appalachian mountains are especially rich in lichen species, featuring some endemic species, such as the Bluff Mountain reindeer lichen (Cladonia psoromica), occurring only in a few acres on Bluff Mountain in Ashe County. Rock gnome lichen (Gymnoderma lineare) occurs only on moist cliffs on high elevation peaks of North Carolina and Tennessee and on moist rocks in lower elevation gorges in North Carolina. Pollution and loss of adjacent Fraser Fir Forests appear to be causing a decline in this species, now reduced to only a few hundred square yards. Most of the other rare lichens in North Carolina are in the mountains. Our knowledge of the lichen flora of the state is poorer than any of the above groups, and our knowledge of rare lichens is even poorer. Additional studies are needed before accurate determinations of the rarity of and threats to most lichen species can be made.

No Natural Heritage Program studies of lichens are anticipated during the next two years.

ANIMALS

MAMMALS

There are approximately 120 species of mammals in North Carolina, including whales and other oceanic species. Of the 100 or more non-oceanic species, 19 of them are listed as either Endangered, Threatened, or Special Concern by the N.C. Wildlife Resources Commission, and the Natural Heritage Program considers another six species to be rare in the state. Most of these 25 rare species are small and difficult to observe, such as bats and shrews. The Mountain region contains the majority of the rare species, such as the Carolina northern flying squirrel (Glaucomys sabrinus coloratus), the Virginia big-eared bat (Plecotus townsendii virginianus), and the southern water shrew (Sorex palustris punctulatus). Several of the largest species, such as the bison, the gray wolf, the elk, and probably the eastern cougar, no longer occur in North Carolina nor in the eastern United States.

Because mammals are often nocturnal and require special techniques to study, much inventory work remains. Distribution and abundance of bats, shrews, and many other groups are still poorly known. Important management and protection concerns for this animal group include protection of bats, particularly from human disturbance in caves and mines, and the loss of habitat for spruce-fir forest species. Fragmentation of habitat is a concern with species requiring large, contiguous habitat blocks and with species adversely affected by habitat edges.

No specific studies of mammals are planned by the Natural Heritage program over the next two years. Data from studies by others will be added to the Natural Heritage Program database.

BIRDS

This is a well-known group in the state, with approximately 200 breeding species among the 420 species recorded in North Carolina. Of this number, 25 are listed as Endangered, Threatened, or Special Concern by the N.C. Wildlife Resources Commission, with another 27 species considered rare by the Natural Heritage Program. Though all types of birds are included among the species of concern, many of the listed species are coastal waterbirds, which tend to nest in colonies. These birds, including herons, egrets, and terns, require rather specialized breeding habitat and may be disturbed or displaced from suitable areas by human activities.

There are a number of threats to North Carolina's bird populations. Within the past 10 years, populations of birds that breed in North America but winter in the tropics, called neotropical migratory birds, have declined drastically in North America. This decline is thought to be due, in part, to the clearing of forests in Central and South America. Habitat fragmentation in North America may also be a significant contributing factor. More thorough documentation of breeding bird populations is needed. Protection and management of various habitats, particularly bottomland hardwood forests, is also needed.

Over the next two years, Natural Heritage Program biologists will continue to participate in the North Carolina Breeding Bird Survey. Information from a variety of sources will be added to the Natural Heritage Program database.

REPTILES

North Carolina is home to approximately 70 species of reptiles, of which 15 are listed as Endangered, Threatened, or Special Concern by the N.C. Wildlife Resources Commission. Five of these listed species are sea turtles, and these are also listed as Endangered or Threatened by the U.S. Fish and Wildlife Service. In addition to the sea turtles, the American alligator, four freshwater turtles, four snakes, and a lizard are on the state list.

Despite their secretive habits, with many nocturnal and/or burrowing species, reptile distribution is fairly well known because of the large number of reptile collectors. Reptiles are often collected live for the pet trade; and such collections may affect population levels of some of the less common species, especially those found in the Sandhills. This is because these species are also stressed by habitat loss. The Sandhills and other sandy parts of the Coastal Plain, such as the southeastern corner of the state, have lost considerable amount of habitat in the past several decades to development, fire suppression and other factors.

No specific studies of reptiles are planned by the Natural Heritage Program for the next two years.

AMPHIBIANS

North Carolina has approximately 80 species of amphibians within its boundaries, and of these, 17 are listed by the N.C. Wildlife Resources Commission. Of these 17, only three are frogs, and the remainder are salamanders. Listed salamanders include three which are completely aquatic: the hellbender (Cryptobranchus alleganiensis), the Neuse River waterdog (Necturus lewisii), and the mudpuppy (Necturus maculosus). No amphibian in the state is on the federal list of Endangered or Threatened species.

Amphibians are moderately well known in terms of distribution. However, much is still to be learned about taxonomy of certain groups, especially montane salamanders. The Southern Appalachians are the center of evolution for Plethodontid salamanders, and new species are still being discovered or split from previously known species.

Threats to amphibians are somewhat different from threats to reptiles, since all amphibian species must lay eggs in water. Ditching, draining, filling, or lowering the water table of limesinks and other natural ponds and pools is a major threat to frogs and salamanders. Acid precipitation may well be a problem, as scientists are finding alarmingly low pH's (4.0 - 4.5) in many ponds and pools; the hatching of eggs and survival of tadpoles are reduced by such acidic conditions. Pollution of streams has adverse effects on all aquatic life, including aquatic salamanders.

No specific studies of amphibians are planned by the Natural Heritage Program for the next two years.

FISHES

Approximately 245 species of freshwater fishes are present in North Carolina and, of these, 47 are listed as Endangered, Threatened, or Special Concern by the N.C. Wildlife Resources Commission. The Natural Heritage Program considers another 11 species to be rare. Despite this large number of freshwater fishes, only three are federally listed: the Cape Fear shiner (Notropis mekistocholas), the spotfin chub (Hybopsis monacha), and the Waccamaw silverside (Menidia extensa). Another species, the shortnose sturgeon (Acipenser brevirostrum), is also federally listed, but it is primarily an estuarine fish. At present, state law does not provide for listing of salt water or estuarine fish species as Endangered or Threatened.

During the next two years, the Natural Heritage Program distribution and abundance of fish species in North Carolina is moderately well known. Many species are confined to one or a small number of rivers, and cannot move between river basins. Protection of fishes is difficult because of the difficulty in protecting water quality in streams. Most water bodies inhabited by rare fishes are not protected. The construction of reservoirs has flooded considerable habitat for stream-inhabiting fishes. Dozens of additional reservoirs are in the planning stages, particularly in the Piedmont and upper Coastal Plain. Many of these reservoirs or proposed reservoirs lie along rivers where water quality or biological diversity is good to excellent.

No studies of fish by the Natural Heritage Program are planned for the next two years.

INSECTS

This group of invertebrates contains the majority of all species of organisms, plant or animal. The number of different kinds of beetles alone exceeds that of all species of plants and all species of vertebrates combined. The most recent compilation by the N.C. Museum of Natural Sciences estimates the total number of insect species in North Carolina at 12,520. This number is already out of date, however. A recent survey of moths and butterflies conducted by the Natural Heritage Program discovered over 120 new species in just four small preserves.

There is no official state list of Endangered, Threatened, or Special Concern insects, but the Natural Heritage Program has identified 176 species as elements in need of protection or at least close monitoring. Possibly two species are now extirpated from North Carolina, the American burying beetle (Nicrophorus americanus) and the regal fritillary (Speyeria idalia). Others are known from just two or three sites in North Carolina, which represents their entire known range. These include the Fraser fir angle moth (Semiothisa fraserata), which is restricted to the rapidly declining stands of high elevation spruce-fir forests, Septima's clubtail dragonfly (Gomphus septima), which appears to be found in only a few Piedmont streams along the edge of the Triassic Basin, and Saint Francis's satyr (Neonympha mitchellii francisci), which is known from only a single population in the center of the Fort Bragg Military Reservation.

Only two general groups of insects have been well studied in North Carolina: agricultural pests and species inhabiting the benthic regions of rivers and larger streams. These aquatic species are relatively well known because of their importance in monitoring water quality. The vast majority of insects, however, are terrestrial and completely benign with regard to human interests. Because of their great diversity and obscure habits, most insect species are unknown in terms of their distribution and life histories. Even such popular groups as butterflies are relatively poorly known within the state. There is a particularly high priority for obtaining information on the species restricted to specialized and vanishing habitats, from high elevation spruce-fir forests to the wet savannas of the Coastal Plain.

During the next two years, the Natural Heritage Program will conduct a study of moths, butterflies and other insects in The Nature Conservancy's Nags Head Woods Preserve and four state parks in the northeastern part of the state.

MOLLUSKS

This group is also very high in numbers of species. In terms of body designs, they are perhaps unequalled in their diversity, ranging from worm-like forms, to snails, to bivalves, to the highly advanced squids and octopuses. The vast majority are marine, but a number of groups have invaded freshwater and terrestrial ecosystems, including over 300 species in North Carolina.

Three groups of mollusks have been given some degree of protection under the N.C. Endangered and Threatened Wildlife Act: freshwater bivalves, freshwater snails, and terrestrial snails. One family of the bivalves, the Unionidae, is the most endangered large group of organisms in the state or nation. One species, the Carolina elktoe (Alasmidonta undulata), was formerly endemic to North Carolina but is now completely extinct. Another endemic species, the Tar River spinymussel (Elliptio steinstansana), has been virtually eliminated from the main channel of the Tar River and now survives as a breeding population only in a single small stream, Swift Creek. Three other species, the Carolina heelsplitter (Lasmigona decorata), the dwarf wedge mussel (Alasmidonta heterodon), and the little-wing pearlymussel (Pegias fabula), are listed as Endangered by the U.S. Fish and Wildlife Service. Some 55% of the 64 species reported from North Carolina are either extirpated or listed by the N.C. Wildlife Resources Commission as Endangered, Threatened, or Special Concern. Mollusk populations have been adversely affected by poor water quality, construction of reservoirs and low-head dams, and alteration of natural stream flows by industrial and municipal water withdrawals.

These same factors also affect a number of the freshwater snails. One species, the Greenfield ramshorn snail (Helisoma eucosmium), may now be extinct; and 17% of 42 species known to occur in North Carolina are on the state list of Endangered, Threatened, and Special Concern species. None are currently federally listed, but three are candidates. Thirty-one species of terrestrial snails are also on the state list, almost all of which are endemic to small areas within the Southern Appalachians. One species, the noonday globe (Mesodon clarki nantahala), is federally listed as Threatened. Threats to these species are primarily due to loss of habitat through clearcutting, but they may also be suffering from acid rain and other forms of air pollution.

Inventories for mollusks may be included in county inventories to be conducted over the next two years.

CRUSTACEANS

The vast majority of crustacean species are marine, where they occupy the same sort of ecological niches occupied on land by the insects. Like the mollusks, several groups have managed to invade freshwater or terrestrial ecosystems, including nearly 300 species in North Carolina. Familiar examples include crayfish, pillbugs, and sowbugs.

Crustaceans, at least the larger species, are eligible for listing under the N.C. Endangered and Threatened Wildlife Act. No species have yet been formally listed, however, although a group of five crayfish has been proposed for listing. Nine species are candidates for inclusion on the federal list of Endangered or Threatened species. The most publicized of these animals is the Greensboro burrowing crayfish (Cambarus catagius), which has only been found in yards in a small residential area within the center of Greensboro.

This group is difficult to survey, and the distribution within the state of most species is virtually unknown. Many crayfish are burrowers and rarely emerge above ground; some are completely subterranean, occuring only in caves. The vast majority of the amphipods, isopods, and other freshwater and terrestrial crustaceans are small to microscopic in size, and special techniques are frequently required for their detection. Like the crayfish, some are subterranean, and many are only found underground in aquifers, collected from just a small handful of wells.

No inventories of crustaceans are planned by the Natural Heritage Program during the next two years.

NATURAL COMMUNITIES

North Carolina's plant and animal species do not live in isolation, but occur together in natural communities. Natural communities are distinct assemblages of plants, animals, fungi and bacteria which interact with one another and with their physical environment. Some of North Carolina's more notable natural communities are Pine Savannas, Southern Appalachian Bogs, Pine/Scrub Oak Sandhills, Diabase Glades, Granitic Flatrocks, Rich Cove Forests, and Pocosins.

Just like individual species, natural communities are biological entities which can be common or rare. Natural communities can be rare because they occur in unusual physical conditions, or they can be rare as a result of human activities. They may run the full spectrum from essentially pristine to severely disturbed. Damaged examples may be able to recover or to be restored to varying degrees. Protection of natural communities serves to protect the full range of community-level diversity, and also provides a means of protecting the more common species and those species which have not yet been discovered. In the ongoing inventory of the natural resources of North Carolina, the Natural Heritage Program locates, maps, and monitors natural communities as elements of natural diversity, just as it does plant and animal species. The focus is both on rare community types and on the best examples of all naturally occurring community types.

The particular combination of plant and animal species found in a given natural community is largely determined by soil type, moisture, temperature, fire regime, disturbance frequency and other physical factors. These factors overlap, so that natural communities tend to occur in continuously varying patterns without discrete boundaries. Nevertheless, many distinctive community types can be recognized.

To facilitate the identification and description of the various natural community types by field workers, and to improve comparability of data between biological researchers, the Natural Heritage Program has developed a classification system for the natural communities of the state. The classification so far includes 116 different communities. Work is still underway on the classification of many aquatic communities, and on the refinement and clarification of terrestrial community types.

For the preparation of this biennial plan, the 116 natural community types have been grouped into 32 biological themes. This allows the discussion of needs, issues, and goals which are common to all of the community types in each theme. Most of the biological themes, presented in the following pages, are accompanied by a map showing the distribution of occurrences of that theme recorded in the Natural Heritage Program database.

SPRUCE-FIR FORESTS

COMMUNITY TYPES

Fraser Fir Forest
Red Spruce--Fraser Fir Forest

GENERAL DESCRIPTION

Forests dominated by red spruce and Fraser fir occur on the high mountain tops in western North Carolina, generally over 5500 feet in elevation. The cold climate of the high elevations is equivalent in some ways to the boreal forests of Canada. However, the climate differs from the north in being less continuously cold and in being much wetter, with both rain and fog tending to concentrate on the mountain tops.

Spruce-fir forests are divided into two natural community types: Fraser Fir Forest and Red Spruce--Fraser Fir Forest, each with several variants. Fraser Fir Forest occurs on the highest mountain tops, where Fraser fir is the only tree species able to persist in the cold, wind, ice, and storms in large numbers. Red Spruce--Fraser Fir Forests occur in slightly less hostile environments where red spruce and yellow birch can also persist in large numbers. Both communities tended under natural conditions to have dense canopies. A variety of distinctive shrubs and herbs, many of them more common in the northern United States but some endemic to the southern Appalachians, occur beneath the canopy. Many places have lush beds of moss and ferns covering the rocky soil and abundant fallen logs.

In recent years all spruce-fir forests have been drastically changed by the balsam woolly adelgid, an introduced insect pest that kills adult Fraser firs. All Fraser Fir Forests now exist as patches of dense young trees or dense blackberry thickets beneath forests of dead snags or tangles of fallen logs. Red Spruce--Fraser Fir Forests have canopies of remnant spruce trees, many of which are also dying. Dense blackberry thickets have grown up beneath the opened canopies. The least affected sites are the lowest elevation examples, which have relatively little fir.

RARE SPECIES

A large number of rare plant and animal species occur in spruce-fir forests. A number are endemics, which evolved in the isolated patches of cold, moist conditions. Endemic plants include Rugel's ragwort (Rugelia nudicaulis), Smoky Mountain mannagrass (Glyceria nubigena), mountain bittercress (Cardamine clematitis), southern twisted-stalk (Streptopus roseus var. roseus), Clingman's hedge-nettle (Stachys clingmanii), and a large number or liverworts and mosses. Endemic animals include the northern flying squirrel (Glaucomys sabrinus coloratus), the Yonahlossee salamander (Plethodon yonahlossee), Weller's salamander (Plethodon welleri), the spruce-fir moss spider (Microhexura montivaga), and a number of beetles. Some of the beetles are known only from a single mountain top. A number of other rare species are northern disjuncts. These include mountain paper birch (Betula papyrifera var. cordifolia), white mandarin (Streptopus amplexifolius), northern beech fern (Phegopteris connectilis), the black-capped chickadee (Parus atricapillus), and the northern saw-whet owl (Aegolius acadicus).

EXAMPLES

Great Smoky Mountains National Park, Swain and Haywood counties
Mount Mitchell State Park and adjacent parts of the Black Mountains, Yancey County
Roan Mountain, Mitchell County
Grandfather Mountain, Avery and Watauga counties
Balsam Mountains and Pisgah Ridge, Pisgah National Forest, Haywood, Transylvania and Jackson counties
Alarka Laurel, Swain County (a very unusual example)

STATEWIDE STATUS

All examples are badly damaged by the balsam woolly adelgid, which has killed essentially all older firs. While fir seedlings and saplings are present in all areas, it is unclear how long they will survive before they become susceptible and succumb to the pest, and whether they will be able to reproduce before then. Research in recent years has also found evidence of declines in growth rates and increases in death rates among spruce trees which are not caused by the balsam woolly adelgid. Though studies have so far been inconclusive, this decline is widely believed to be caused by some form of air pollution, which is concentrated on the mountain tops by the heavy fog and rain.

With regard to land protection, spruce-fir forests are one of the best represented themes in the state. The major areas are largely in public ownership and most are under one or more forms of protective designation. The unique low elevation example at Alarka Laurel, the only known example of one of the variants, is on private land and is not currently protected. Much of the spruce-fir forest in the Plott Balsam range is also on private land and unprotected, and some unprotected areas remain in other ranges as well.

INVENTORY NEEDS

This theme is a low priority for additional general inventory for new sites. The distribution of the major spruce-fir forests remnants is well known. The Plott Balsam range needs some additional inventory, and scattered small areas probably remain to be discovered in other ranges. Some of these areas will be covered by inventories already in progress.

While the major sites are well known, the drastic changes in these communities have made much of the detailed information out of date. The current status of the rare plant and animal species dependent on spruce-fir forests is poorly known in most areas and is a higher priority for inventory.

MANAGEMENT ISSUES

Balsam Woolly Adelgid: The most important management issue for spruce-fir forests is the balsam woolly adelgid. Unfortunately, little can be done about this pest. Spraying with insecticidal soap or other insecticides can control the adelgids (at definite expense to native insects) but can only be applied to narrow bands along roads. Early experiments with biocontrol (also at unknown expense to native insects) were unsuccessful. Solutions to the air pollution problem will require a very large scale approach in a several-state region.

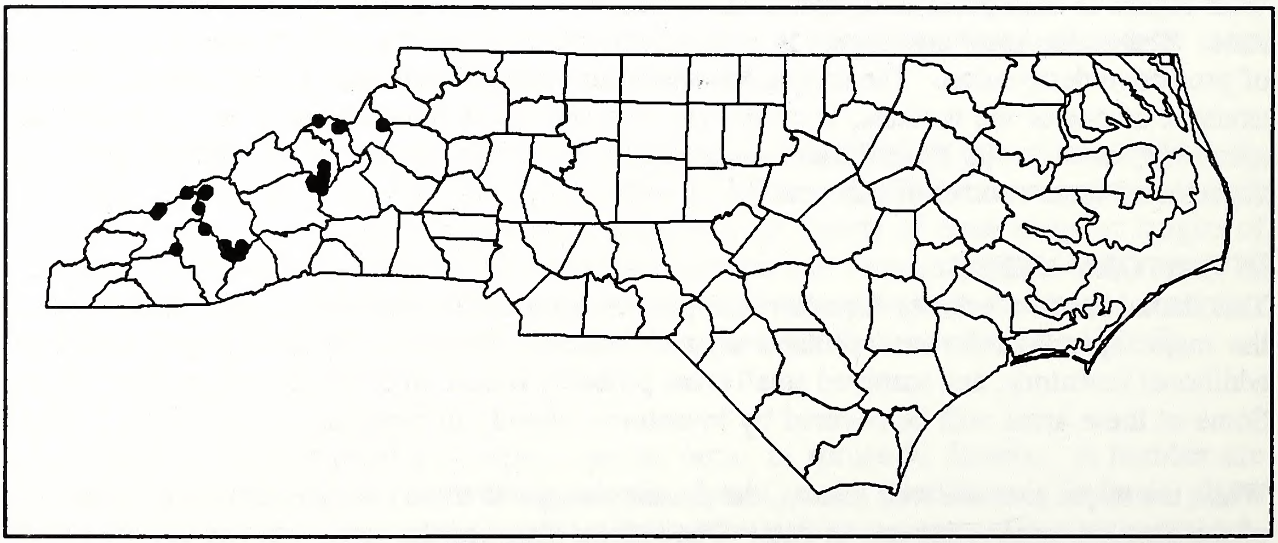
Fire: There may be some need for protection from wild fire. Spruce-fir forests did not naturally burn and are heavily damaged by fire. Areas burned in 1910 still show little sign of recovery. While these areas are not naturally prone to fire, intense fires occurred when logging left large amounts of dried slash, and the large amount of dead wood produced by the Balsam Woolly Adelgid could have a similar effect.

LONG TERM GOALS

Continued protection of land containing known examples is important. Aside from the region-wide problems mentioned above, these communities appear to require little active management, and may be able to recover. Continued support of research for solutions to the problems of the Balsam Woolly Adelgid and of air pollution are also important.

TWO YEAR PLAN

No additional inventory work is planned for the next two years. The program will continue to encourage protection efforts by other agencies and organizations.



Recorded Occurrences of Spruce-Fir Forests

GRASS AND HEATH BALDS

COMMUNITY TYPES

Grassy Bald
Heath Bald

GENERAL DESCRIPTION

Balds are treeless shrub or herb-dominated communities of the high mountains. Grassy Balds are open meadows typically dominated by mountain oatgrass and sedges, with a fairly diverse mixture of other species. They usually occur on broad ridgetops. Heath Balds are dense thickets of tall shrubs. Catawba rhododendron and mountain laurel are the most common dominants. An unusual variant at Roan Mountain is dominated by green alder, not found elsewhere in North Carolina. Most Heath Balds are on sharp spur ridges, but some occur on rounded peaks or ridgetops.

The ecological factors creating balds are not well understood. The treeless areas do not represent a climatic timberline, and often occur near higher peaks that are forested. Harsh climate and shallow soil seem to be a factor in some, particularly Heath Balds, but many examples of both community types are being invaded by trees and, in the case of Grassy Balds, shrubs. Fire may have been a factor in keeping balds open, but many bald sites do not appear prone to fire, and are surrounded by vegetation that apparently did not burn. Some places that superficially resemble balds have been found to have been cleared of forest in historical times, but other balds apparently were open throughout history. The presence of disjunct species which require open habitat suggests that some balds have been open since the Ice Age.

RARE SPECIES

Grassy Balds are relatively rich in rare species. They include both southern Appalachian endemics such as Gray's lily (Lilium grayi) and Roan rattlesnakeroot (Prenanthes roanensis), and northern disjuncts such as wood lily (Lilium philadelphicum), spike trisetum (Trisetum spicatum), Canada reedgrass (Calamagrostis canadensis), alder flycatcher (Empidonax alnorum), and New England cottontail (Sylvilagus transitionalis). Heath Balds are fairly low in numbers of rare species. Alder flycatchers occur in the alder-dominated bald at Roan Mountain. Pinkshell azalea (Rhododendron vaseyi) occurs in some balds.

EXAMPLES

Roan Mountain and Big Yellow Mountain, Avery and Mitchell counties
Andrews Bald and Silers Bald, Great Smoky Mountains National Park, Swain County
Grandfather Mountain, Avery and Watauga counties
Craggy Dome and Pinnacle, Buncombe County

STATEWIDE STATUS

The majority of Grassy Balds and Heath Balds in the southern Appalachians are probably in North Carolina. It is uncertain how many once existed. Many places are named balds but do not now have bald communities. Invasion by trees may have eliminated many balds, but it is unclear how many areas called balds were really of natural origin. Remaining Grassy Balds that appear to be of natural origin are very rare at present. All six examples known are at least partially under protective designation. Thirteen sites with Heath Bald communities are protected. Not all of the community and geographic variation is well protected, however, and more examples are needed of underrepresented variants and of sites in the less well known mountain ranges.

INVENTORY NEEDS

Grassy Balds and Heath Balds are a low to moderate priority for inventory. Knowledge of the distribution of balds is patchy. Balds in the larger mountain ranges are fairly well known, but some examples of Heath Bald, in particular, likely remain to be found in less well explored mountain ranges. Much more detailed study is needed of some components, especially invertebrates, and of ecological processes and management needs. The range of natural variation and classification of variants also need more study.

MANAGEMENT ISSUES

Vegetational Succession: All Grassy Balds show a tendency to be invaded by blackberries, shrubs, and trees, eliminating the herbaceous vegetation. Some Heath Balds appear to be stable, but others apparently tend to succeed to forest. While succession is natural in nonforested areas that were recently opened by natural or artificial disturbance, it is also occurring in balds that have been open for a very long time. Without some kind of active management, all examples of Grassy Balds would probably be gone in a few decades. In the absence of knowledge of the factors which naturally kept the balds open in the past, managers have tried a variety of techniques, including hand cutting, grazing, burning, and herbicide treatment. Hand cutting is the least drastic management technique, but it is very time-consuming and expensive.

Fire: There is strong evidence that fire occurs naturally in many Heath Balds and may be necessary for their long-term health. Fires are likely to be intense in the dense vegetation. Prescribed burning methods have not been developed for these communities. There is not similar evidence that fire played a major role in the ecology of Grassy Balds, though it may have occurred. More study is needed on this question.

Exotic Species: On Grassy Balds, grazing has been the major land use. On the most heavily grazed balds, exotic pasture weeds and grasses have become established at the expense of native species. Control of exotic species will be needed to restore these examples to more natural conditions. Methods for doing this without damage to native species are still being developed.

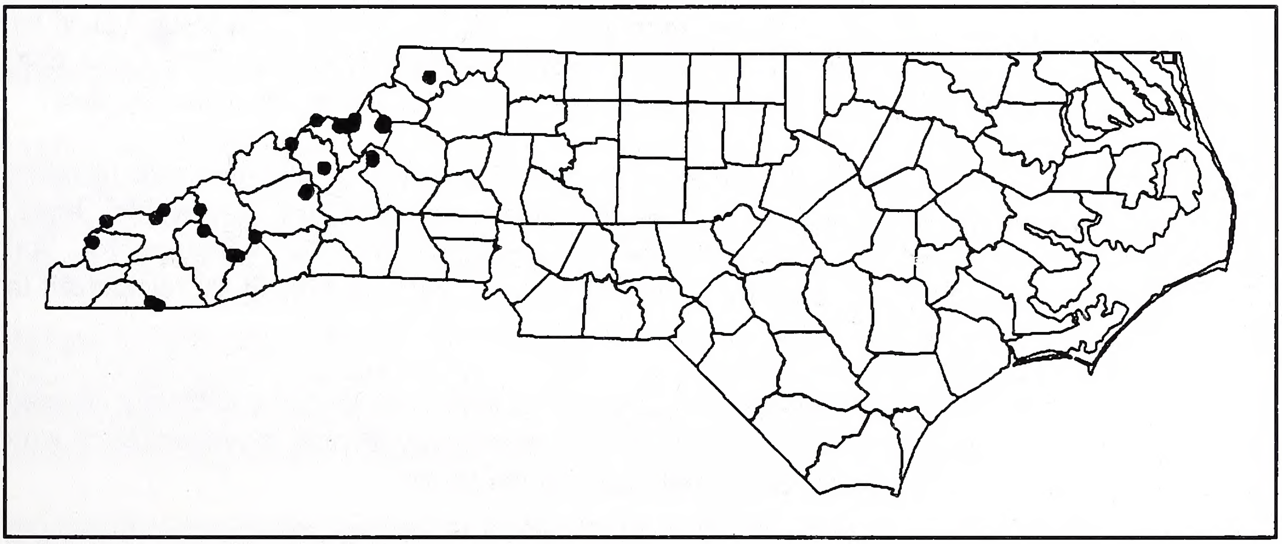
Trampling: The openness of Grassy Balds makes them attractive to the public. The grassy vegetation is susceptible to trampling in areas of concentrated public use. This is seldom a problem in Heath Balds.

LONG TERM GOALS

Given the rarity of Grassy Balds, any new viable examples that are discovered should be protected and managed. More protected examples of Heath Balds are also needed, especially in the southern part of the mountains and in the smaller ranges.

TWO YEAR PLAN

During 1993-1995, the Natural Heritage Program may conduct geographically focused inventories in several mountain areas which have the potential for occurrence of bald communities. The program will continue to participate in the Roan Mountain Management Advisory Group regarding management of the most significant Grassy Bald complex.



Recorded Occurrences of Grass and Heath Balds

NORTHERN HARDWOOD FORESTS

COMMUNITY TYPES

Northern Hardwood Forest, Typic Subtype
Northern Hardwood Forest, Beech Gap Subtype
Boulderfield Forest

GENERAL DESCRIPTION

Northern Hardwood Forests are found on high mountain slopes with a cool climate and high levels of rainfall. They are dominated by combinations of moist-site hardwoods, such as yellow birch, beech, yellow buckeye, and sugar maple. The herb layer is often lush, and may range from low to fairly high diversity. These forests are subject to periodic widespread disturbances, such as ice storms or severe winds, which provide canopy openings but probably seldom or never remove the whole canopy at once.

The Beech Gap Subtype occurs in high elevation gaps and peaks, where beech trees stunted by the wind predominate. In the most extreme cases, the tree canopy may be reduced to shrub size. The trees may be quite old, although small, as growth and reproduction are relatively slow.

The Typic Subtype varies in composition and diversity. Some have a lawn-like ground cover of just a few species of sedges and grasses, while others have a lush and diverse herb layer. Three recognized variants of this community type are determined primarily by topography. Soil chemistry is also an important factor, and additional variants will undoubtedly be recognized in the future.

In Boulderfield Forests, Ice Age freeze-thaw processes have left the ground completely covered with large boulders; very little soil is present. These areas are dominated by yellow birch with a distinctive undergrowth of gooseberries and moss on the rocks.

RARE SPECIES

A moderate number of rare species are found in the northern hardwood communities. Rare plant species include trailing wolfsbane (Aconitum reclinatum), mountain bittercress (Cardamine clematitis), bent avens (Geum geniculatum), nodding mandarin (Disporum maculatum), roan rattlesnakeroot (Prenanthes roanensis), Clingman's hedge-nettle (Stachys clingmanii), and southern twisted-stalk (Streptopus roseus var. roseus). Rare animals include the northern flying squirrel (Glaucomys sabrinus coloratus) and breeding populations of the yellow-bellied sapsucker (Sphyrapicus varius).

EXAMPLES

Great Smoky Mountains National Park, Swain and Haywood counties
Middle Creek Research Natural Area, Pisgah National Forest, Yancey County
Craggy Mountains, Buncombe and Yancey counties
Roan Mountain, Pisgah National Forest, Mitchell County
Grandfather Mountain, Avery and Watauga counties

STATEWIDE STATUS

Although some examples occur in Virginia, Kentucky, Tennessee, and Georgia, North Carolina contains most of the examples of this theme which occur in the southern Appalachians. The Typic Subtype of the northern hardwoods community has large acreages protected on national park and national forest lands, but some variations of this diverse type, particularly those on rich soils, may still be in need of protection. Several examples of the less common Boulderfield Forest type are on protected lands, although a number of excellent examples remain unprotected. The Beech Gap Subtype is most abundant in Great Smoky Mountains National Park, where all are protected. Some examples in other mountain ranges still warrant protection.

INVENTORY NEEDS

Northern hardwood forests are fairly well known in the more accessible parts of the larger mountain ranges. They remain poorly known in some of the smaller ranges in the northern and southern parts of the state and in the more remote areas. Plant and animal records follow a similar pattern, and many probably remain to be discovered in these areas. Information on invertebrates is particularly poor. Better understanding of the natural variation in this complex theme is needed.

MANAGEMENT ISSUES

Air Pollution: These high elevation communities may be subject to growth declines similar to those noted in spruce-fir communities because they are subject to similar atmospheric conditions. Growth decline problems may be related to air pollution.

Natural Disturbances: Fire is probably a fairly rare event in the cool, moist environment of these communities. Because most of the component trees have thin bark, rare fires might produce significant disturbance. Recent experience suggests that ice storms are an important natural disturbance factor, damaging trees over large areas and killing some.

Wild Boar: Introduced populations of European wild boar have caused severe damage in these communities in the Great Smoky Mountains and some nearby areas.

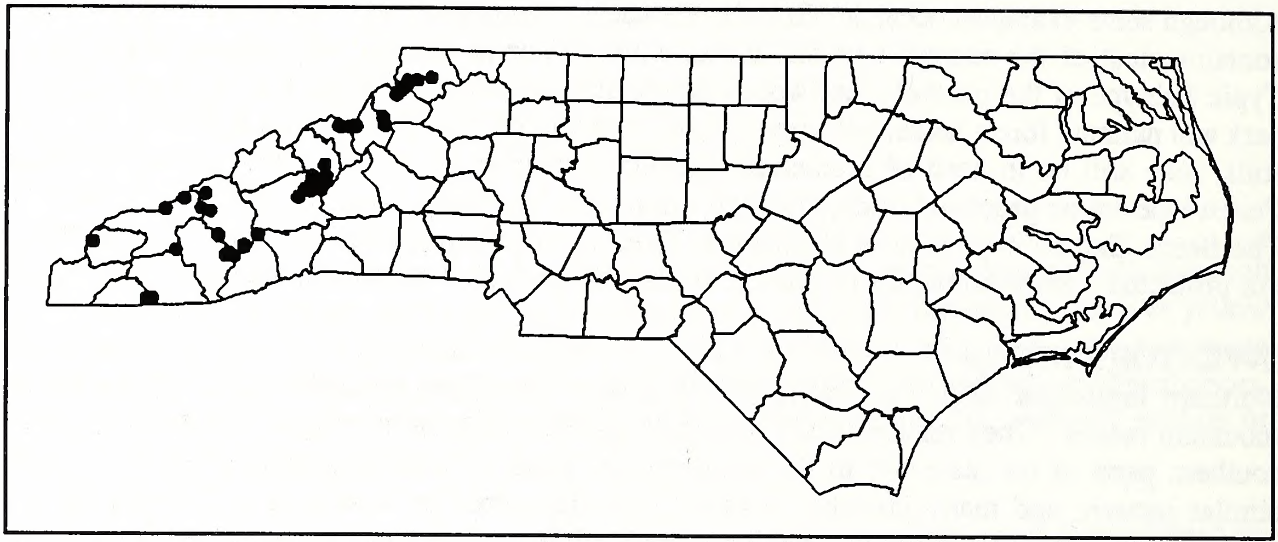
Gypsy Moth: The introduced gypsy moth, a major pest in the northeastern states, may be a threat to North Carolina's Northern Hardwood Forests in the next five to ten years.

LONG TERM GOALS

Although many good examples are protected, it would be beneficial to ensure that protected examples include representation of the full biological and geographical variation of this theme.

TWO YEAR PLAN

This theme is not a primary focus for inventory work over the next two years, but geographically focused inventories in several mountain areas are expected to identify additional northern hardwood forests. The Natural Heritage Program and the U.S. Forest Service are working cooperatively to identify potential sites on the national forests to add to the Registry of Natural Heritage Areas.



Recorded Occurrences of Northern Hardwood Forests

MOUNTAIN COVE FORESTS

COMMUNITY TYPES

Rich Cove Forest
Acidic Cove Forest
Basic Mesic Forest, Montane Calcareous Subtype
Canada Hemlock Forest

GENERAL DESCRIPTION

Cove forests are some of the most well-known and recognized community types in the mountains, occurring on sheltered, moist, low to moderate elevation sites. They are characterized by a dense forest canopy of moisture-loving trees. The Rich Cove Forest type, occurring in the most fertile sites, has a lush herb layer and relatively few shrubs. The high diversity in all vegetation layers makes this forest of great interest to botanists and ecologists.

The Acidic Cove Forest, which occurs in similar but less fertile sites, is dominated by the more acid tolerant subset of the Rich Cove species, and has undergrowth dominated by ericaceous shrubs such as rhododendron, rather than by herbs. Canada Hemlock Forests have similarly dense shrub layers and relatively few herbs. Basic Mesic Forests occur on rare outcrops of limestone, marble, or dolomite, and are dominated by trees most favored by high pH soils.

These communities are naturally relatively stable, uneven-aged climax forests, with trees up to several centuries old. Tree reproduction occurs in canopy gaps, which result from wind, disease, or other causes of mortality in the canopy trees. Fire is probably a rare event in these moist, sheltered sites.

Cove forest variations have not been well studied, but distinctive variants apparently occur in low elevation areas in the Blue Ridge escarpment and foothills; in gorges in the high rainfall southern escarpment gorges; on sites with calcareous substrates, such as marble or amphibolite; and on high elevation sites transitional to Northern Hardwoods. Much variation may be expected in the transition to other community types. The large number of species makes possible many different variations in composition.

RARE SPECIES

As might be expected from the notably high diversity found in Rich Cove Forests, the number of rare plant species found here is relatively high. Examples include Manhart's sedge (Carex manhartii), largeleaf waterleaf (Hydrophyllum macrophyllum), bleeding heart (Dicentra eximia), and trailing wolfsbane (Aconitum reclinatum). Rare animals such as the crevice salamander (Plethodon longicrus), the cerulean warbler (Dendroica cerulea), many other rare birds, and several rare land snails also occur.

Acidic Cove Forests have very few rare species. Basic Mesic Forests have a few rare plants, such as wall-rue (Asplenium ruta-muraria), specialized for calcareous soils or for the small rock outcrops within the forest.

EXAMPLES

Great Smoky Mountains National Park, Swain and Haywood counties
Joyce Kilmer Memorial Forest, Nantahala National Forest, Graham County
Middle Creek Research Natural Area, Pisgah National Forest, Yancey County
Grandfather Mountain north slope, Avery and Watauga counties
Bluff Mountain, Ashe County
Garden Creek Natural Area, Stone Mountain State Park, Wilkes County
Redbank Cove, Blue Ridge Parkway, Haywood County

STATEWIDE STATUS

Mountain cove forests are fairly widespread throughout the Mountain region and foothills, with a relatively high number of protected examples. A few protected examples are old growth, but most have been affected by past logging, which may have reduced their diversity as well as changed their structure. Logging can result in an increase in shade-intolerant species such as tulip poplar and black locust, and may also lead to a proliferation of shrubs and a reduction in the herb layer.

Representation on protected land is poor for several of the variants, as well as for some geographic areas. The Basic Mesic Forest, Montane Calcareous Subtype, is extremely rare in North Carolina, with only two known examples.

INVENTORY NEEDS

Mountain cove forests in general are a moderate priority for inventory, with needs concentrated on the less studied areas and on the less well known variants. Because of its rarity, the Basic Mesic Forest, Montane Calcareous subtype is a high priority for inventory. Work on animals has been less extensive, particularly for invertebrates. Diversity of land snails may be high in calcareous areas.

MANAGEMENT ISSUES

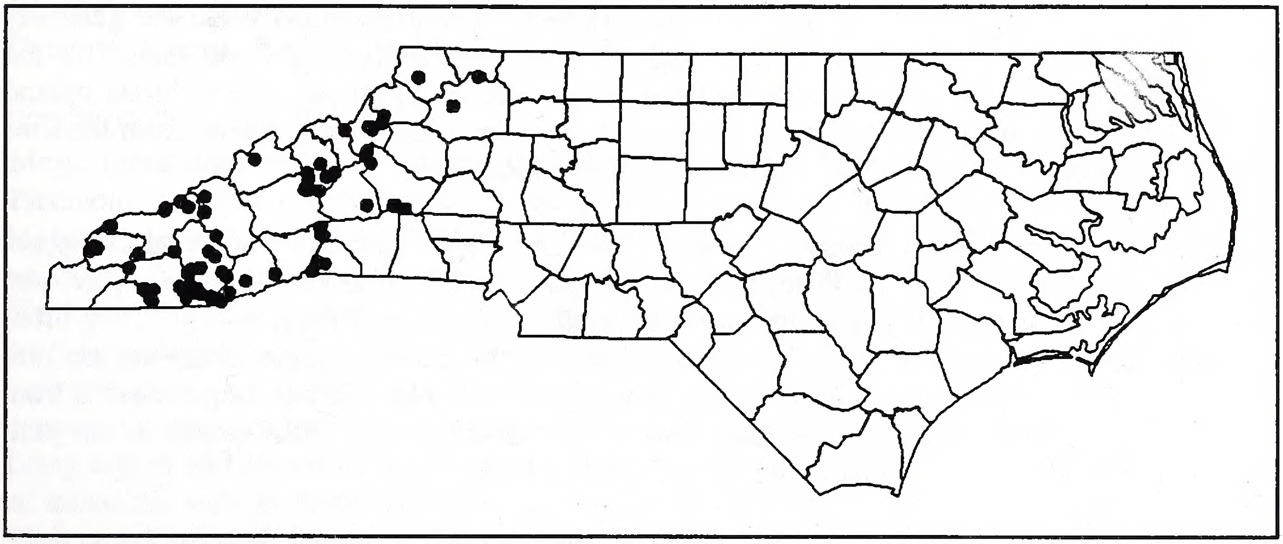
Collection of Plants: Mountain cove forests have several species that command high prices and are frequently collected, including rare species such as ginseng and golden seal, and more common plants such as ramps, galax, and mats of moss. Harvesting alters natural population processes for these species, and can threaten populations if taking is heavy.

LONG TERM GOALS

Given their rarity, all good quality examples of Basic Mesic Forest, Montane Calcareous Subtype, should be protected. Protection efforts for the other community types should focus on old growth examples, on geographic areas with few protected examples, and on sites with rare species.

TWO YEAR PLAN

In 1993-1995, the Natural Heritage Program will conduct inventories on one or more National Forest ranger districts which have high potential for discovery of new cove forest communities. Inventories in several other mountain areas also have high potential for describing new cove forest sites. The Natural Heritage Program will determine Registry eligibility for sites on the national forests, may initiate contact with several private owners of high priority sites, and will encourage other protection efforts.



Recorded Occurrences of Mountain Cove Forests

PIEDMONT AND COASTAL PLAIN MESIC FORESTS

COMMUNITY TYPES

Mesic Mixed Hardwood Forest, Piedmont Subtype
Mesic Mixed Hardwood Forest, Coastal Plain Subtype
Basic Mesic Forest, Piedmont Subtype
Basic Mesic Forest, Coastal Plain Subtype

GENERAL DESCRIPTION

Mesic forests occur on sites that are moist but not wet. In the Piedmont these are generally north-facing slopes, sheltered ravines, or high terraces on the edges of floodplains. In the Coastal Plain, mesic forests occur in similar sites and also on moist portions of broad upland flats and on small island ridges surrounded by swamps. These sites are sheltered from the fires that are a major natural shaper of vegetation in the Coastal Plain.

Mesic sites are among the most favorable environments for plant growth. They tend to support dense forests dominated by moisture-loving nonwetland trees such as beech, tulip poplar, and red oak. They usually have well-developed understory, shrub, and herb layers. They often contain species that are common in the mountain parts of the state or farther north but are rare in the southern Piedmont and Coastal Plain. Some species may be disjunct long distances from cooler areas. At least some of these disjuncts are remnants of wider distributions in the past, such as during the cooler, moister climates of the Ice Ages.

Mesic Mixed Hardwood Forest communities occur on mesic sites that have typically acidic soils. The much rarer Basic Mesic Forests occur on soils that are neutral to slightly basic in pH. They are more diverse than the Mesic Mixed Hardwood Forets. They have species that require high pH, such as columbine, Atlantic isopyrum, green violet, and deciduous wild ginger, as well as more common species. The Coastal Plain and Piedmont subtypes cannot be separated by any particular species, but differ in their overall flora. Several distinctive variants are recognized in the Coastal Plain, including the Swamp Island, Mesic Flat, and Bluff/Slope variants of Mesic Mixed Hardwood Forest, and the Terrace Slope and Marl Outcrop variants of Basic Mesic Forests.

RARE SPECIES

Piedmont and Coastal Plain mesic forests, particularly the Basic Mesic Forests, are moderately rich in rare plant species. Some of the rare species are more common in areas farther west where limestone is abundant. Examples include wild hyacinth (Camassia scilloides), leatherwood (Dirca palustris), and mock orange (Philadelphus spp.). Others are restricted in range, including Atlantic isopyrum (Enemion biternatum), Piedmont aster (Aster mirabilis), buttercup phacelia (Phacelia ranunculacea), and Virginia least trillium (Trillium pusillum var. virginianum). Few rare animals are known to be tightly associated with these communities, but various species use them along with other communities. Little work has been done on invertebrate groups like insects and snails, several of which show disjunct or relict patterns similar to some of the plants.

EXAMPLES

William B. Unstead State Park, Wake County
Eno River State Park, Durham and Orange counties
Cliffs of the Neuse State Park, Wayne County
White Pines Natural Area, Chatham County
New Hope Creek and Oosting Natural Area, Duke Forest, Orange County
Flanner Beach, Croatan National Forest, Craven County
Catsburg Natural Area, Durham County
Uwharrie River Slopes, Montgomery County
Island Creek, Croatan National Forest, Jones County
Camassia Slopes, Halifax County

STATEWIDE STATUS

Mesic forest sites make up only a small minority of the landscape in the Coastal Plain and Piedmont, but they are widespread. Because they often occur on bluffs and dissected lands, a higher proportion than of most upland communities has escaped destruction. Logging has been universal, however, and examples with old canopies are rare. A number of Mesic Mixed Hardwood Forests, some in good condition, are protected in registered areas and on public lands such as state parks. The Swamp Island and Mesic Flat variants in the Coastal Plain are very rare and almost no examples are protected. The Mesic Flats variant, once widespread, is not protected from development by steep or dissected topography, and the remnants are rapidly being logged and converted to other uses. Basic Mesic Forests are also rare, reflecting the rarity of nonacidic soils in North Carolina. A few good examples are protected in both the Coastal Plain and Piedmont, but more are needed to represent this diverse community type.

INVENTORY NEEDS

Portions of this theme are of moderate to high priority for inventory. The recently completed Albemarle/Pamlico Estuarine Study natural area inventories covered substantial portions of the Coastal Plain as well as part of the Piedmont, and identified many examples of this theme. An ongoing inventory for communities associated with mafic rocks in the Piedmont has Basic Mesic Forest, Piedmont Subtype, as one of its primary targets and has already found a number of examples. The rest of the Coastal Plain needs further inventory. Inventory for animals is needed in most areas.

MANAGEMENT ISSUES

Exotic species: Mesic forests, occurring in some of the most favorable environments for plants, are very susceptible to invasion by exotic species, particularly Japanese honeysuckle. Basic Mesic Forests, with their high fertility, are particularly vulnerable. While intact examples appear to resist exotics, opening of the canopy and clearing or disturbance on adjacent lands may allow rapid invasion.

Fragmentation: These communities, while usually naturally small, occur naturally in large mosaics of forested upland and bottomland communities. Large areas and freedom from edge effects may be needed for the long term viability of some species, particularly animals.

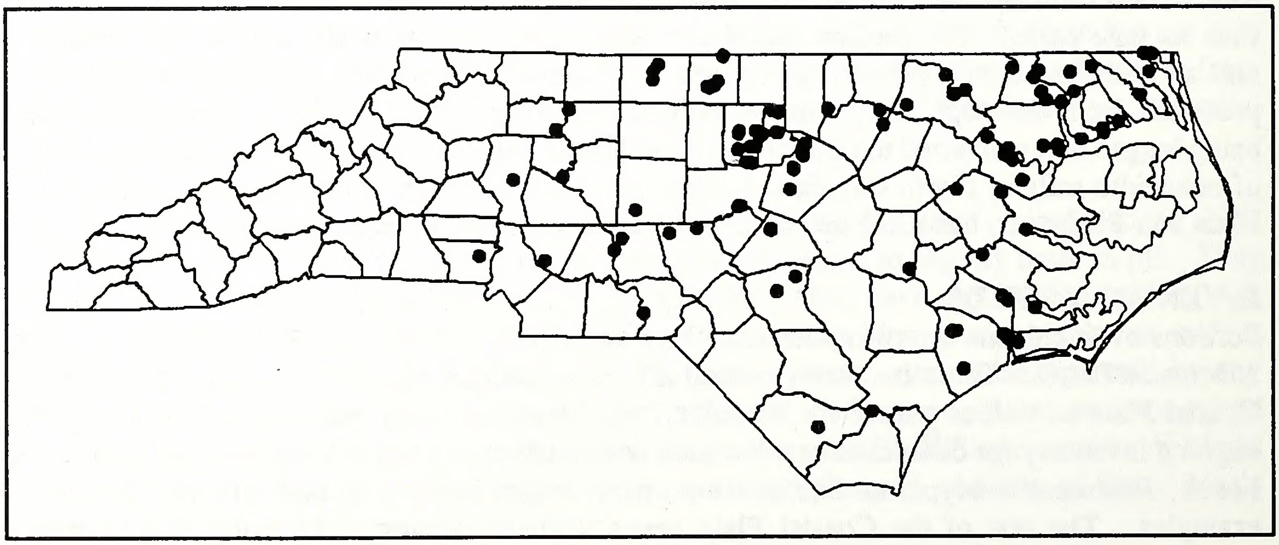
Many examples now exist as small patches, bordered by cleared or heavily disturbed land. They may not be able to support all the component species. Attention to forested corridors and connections to other natural areas may help reduce this effect.

LONG TERM GOALS

More protected examples of these community types are needed, particularly of the rare types, subtypes, and variants. For the common variants, the emphasis should be on protecting mature to old examples that are parts of larger natural areas.

TWO YEAR PLAN

In 1993-1995, the Natural Heritage Program will continue the inventory of communities associated with Piedmont mafic rocks. Geographically focused inventories in several Piedmont and Coastal Plain counties will be initiated or continued.



Recorded Occurrences of Piedmont and Coastal Plain Mesic Forests

PIEDMONT AND MOUNTAIN DRY CONIFEROUS WOODLANDS

COMMUNITY TYPES

Carolina Hemlock Bluff
White Pine Forest
Pine--Oak/Heath
Montane Red Cedar--Hardwood Woodland

GENERAL DESCRIPTION

The vast majority of land in the Piedmont and Mountain regions is dominated by hardwood forests. Less common are dry coniferous forests, which occur at mid to low elevations in several kinds of specialized sites that are drier than most mountain settings. They occur primarily in the mountains and are found in a few mountain-like sites in the Piedmont. Piedmont Longleaf Pine Forests, although dominated by coniferous trees and sometimes dry, are included with the more closely related Dry Longleaf Pine Communities theme rather than here.

Pine--Oak/Heath communities occur on sharp ridgetops and spur ridges, where shallow soils and exposure to drying winds and lightning prevent development of a closed hardwood forest. Extremely acidic soils, created by leaching and by the acidity of plant leaf litter, may also be a factor. The canopy is generally open and dominated by table mountain pine, pitch pine, Virginia pine, or chestnut oak, or by combinations of these species. A dense tall shrub layer dominated by mountain laurel or rhododendron occurs beneath the canopy and often makes these communities nearly impenetrable. Herbs are few and sparse, but characteristic acid-loving species such as turkey beard, bracken fern, and galax often occur in openings among the shrubs.

Carolina Hemlock Bluffs occur in settings similar to Pine--Oak/Heath, but usually on steep bluff-like side slopes. Carolina hemlock dominates the canopy. The shrub and herb layers are generally similar to Pine--Oak/Heath but may be more open.

White Pine Forests are poorly understood communities. While white pine is a common successional tree in mountain hardwood forests and often dominates old fields and managed forests, natural forests of it most typically occur on the walls of steep gorges.

Montane Red Cedar--Hardwood Woodland is a recently discovered community type which occurs on shallow soils on gentle slopes. Smooth rock outcrops are usually found in association with it. The open canopy is dominated by combinations of eastern red cedar, white ash, and hickory. The undergrowth is usually grassy with patchy shrubs. A number of the species suggest that the soils are less acidic than typical mountain soils.

RARE SPECIES

Most Piedmont and Mountain dry coniferous forests are low in rare species. A few rare species, such as large witch-alder (Fothergilla major) and mountain golden-heather (Hudsonia montana), occur in openings in a few Pine--Oak/Heath communities. An exception to the general lack of rare plants is the Montane Red Cedar--Hardwood Woodland, which often supports several rare plant species such as shooting star (Dodecatheon meadia). Sullivant's maned-moss (Macrocoma sullivantii), a rare moss which grows on red cedar branches, is often present.

EXAMPLES

Linville Gorge, Pisgah National Forest, Burke County
Great Smoky Mountains National Park, Swain and Haywood counties
Beartree Ridge, Pisgah National Forest, McDowell County
Doughton Park, Blue Ridge Parkway, Wilkes County
Devil's Garden, Stone Mountain State Park, Wilkes and Alleghany counties
Cedar Cliff/The Pinnacle, Nantahala National Forest, Macon County
Hanging Rock State Park, Stokes County
Pilot Mountain State Park, Surry County
Crowders Mountain State Park, Gaston County

STATEWIDE STATUS

It is uncertain what portion of these communities occur in North Carolina. Pine and cedar communities in the Ridge and Valley and Cumberlands regions of adjacent states may or may not represent the same theme. This theme is rare in the Piedmont. Pine--Oak/Heath occurs on several high monadnocks in the upper Piedmont, and Carolina Hemlock Bluff occurs on one. Four state parks protect examples of these communities in the Piedmont. In the mountain region, Pine--Oak/Heath is more common, though not very extensive. Substantial examples are protected in the Great Smoky Mountains National Park, and several others are protected in other Registered Natural Heritage Areas, but geographic representation is only moderate. Carolina Hemlock Bluffs are much rarer. Several high quality examples are protected, but protection is needed for other examples. The distribution and abundance of White Pine Forest is poorly known. Good examples are protected in Linville Gorge, but only one other small example is protected. Montane Red Cedar--Hardwood Woodland appears to be one of the rarest community types in North Carolina. Only one example is protected.

INVENTORY NEEDS

Knowledge of Piedmont and Mountain Dry Coniferous Woodlands is very patchy. The mountains in the southwestern part of the state, along the Tennessee border, and in much of the northern escarpment, are places likely to support these communities, but they have not been well explored. Many lower elevation areas are poorly known even within more studied ranges. In the Piedmont, the more distinct monadnocks are fairly well known, but large parts of the South Mountains and Brushy Mountains are unexplored.

The ecological nature and dynamics of these communities are poorly known, and it is therefore difficult to judge the quality of examples when they are discovered. Variants are not known. It is also difficult to determine the best management techniques. Additional basic information on more occurrences will help in addressing these questions, though more intensive research is also needed.

MANAGEMENT ISSUES

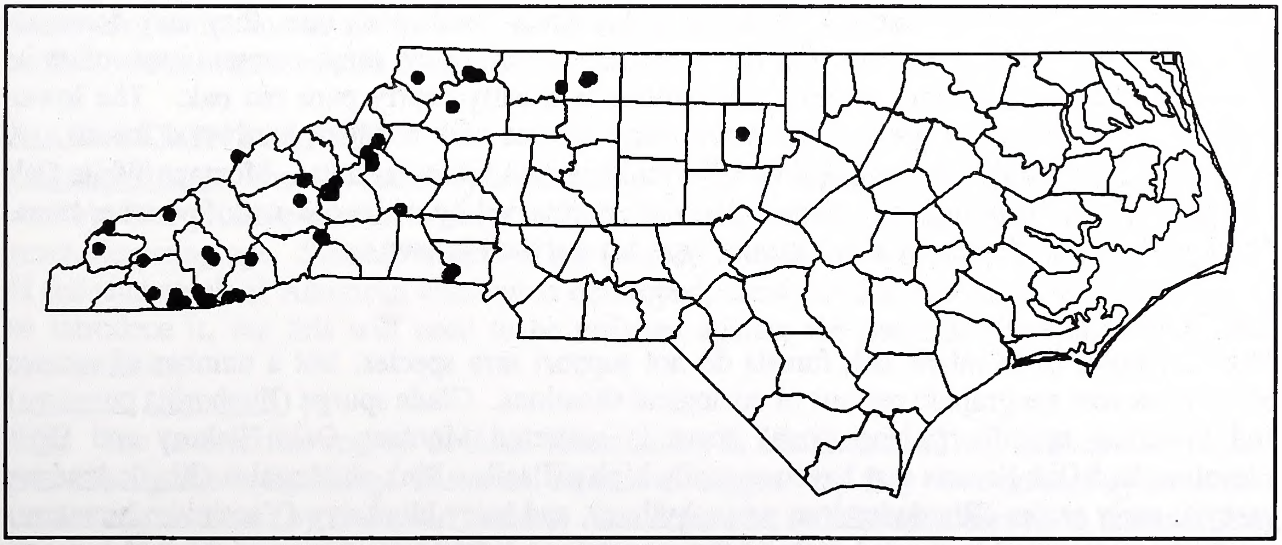
Fire: Pine--Oak/Heath communities occur on exposed rocky ridges and are very subject to lightning strikes. It has been suggested that fire is necessary to open the dense shrubby vegetation and allow regeneration of pines. Table mountain pine and pitch pine can tolerate some fire. Virginia pine, white pine, Carolina hemlock, and eastern red cedar are not considered fire-tolerant. It may be, however, that canopy-killing fire is needed to halt succession to hardwoods and to create the openings and bare mineral soil that allow the conifers to reproduce.

LONG TERM GOALS

Because of their rarity, all known Montane Red Cedar--Hardwood Woodland communities should ideally be protected. The rarity of Carolina Hemlock Bluffs and high quality natural White Pine Forests make protection of nearly all good examples desirable. Protection of more good examples of Pine--Oak/Heath is needed in most parts of its range, particularly in areas where none are protected.

TWO YEAR PLAN

In 1993-1995, the Natural Heritage Program will conduct an inventory of one or more ranger districts in mountain national forests. These inventories will explore poorly known areas with potential for these communities. An inventory in the South Mountains will also cover areas with potential for dry coniferous forests. The potential for registry of several examples of this theme on U.S. Forest Service lands will be explored during this period.



Recorded Occurrences of Piedmont and Mountain Dry Coniferous Woodlands

MONTANE OAK FORESTS

COMMUNITY TYPES

High Elevation Red Oak Forest
Montane White Oak Forest
Chestnut Oak Forest
Montane Oak--Hickory Forest

GENERAL DESCRIPTION

Montane oak forests occupy much of the landscape in the Mountain region, covering the dry to intermediate slopes and ridgetops over a broad elevational range. All of these communities once included a large component of American chestnut, before the blight in the early part of the century eliminated it as a canopy species. Today, chestnut persists only as short-lived sprouts from old root systems.

Most of the four natural community types recognized within this theme are broad types with many variants that could be recognized. Chestnut Oak Forests occur in the driest sites of the four - low to intermediate elevation steep slopes and sharp ridges. Chestnut oak or scarlet oak are the dominant trees, and an understory of acid-loving plants such as sourwood, black gum, red maple, blueberries, and huckleberries is usually present. Montane Oak--Hickory Forests are dominated by a mixture of oaks, of which white oak is a prominent part. Hickories are usually a minority component, but are sometimes absent. The understory is generally more diverse than in the other oak forests, with species such as flowering dogwood, flame azalea, and huckleberries often dominant.

High Elevation Red Oak Forests occur at medium to high elevations. In the southern part of the state, where spruce-fir forests are absent and northern hardwoods rare, they may dominate the highest ridges and summits. Farther north they occur below these communities, often in broad zones along mountain slopes. The canopy is usually nearly pure red oak. The lower layers of vegetation vary greatly, but share many species with northern hardwood forests. A detailed study of High Elevation Red Oak Forest identified seven variants. Montane White Oak Forests occur at fairly high elevations. They are dominated by white oak with few other trees. The conditions producing this community type are not well known.

RARE SPECIES

Most examples of Montane oak forests do not support rare species, but a number of species occur in narrow geographic regions or ecological situations. Glade spurge (Euphorbia purpurea) and mountain catchfly (Silene ovata) occur in scattered Montane Oak--Hickory and High Elevation Red Oak Forests that have unusually high pH soils. Pink-shell azalea (Rhododendron vaseyi), early azalea (Rhododendron prinophyllum), and hairy blueberry (Vaccinium hirsutum) are fairly widespread in limited parts of the mountains. Rare local species of salamanders and snails may occur with similar restricted ranges. Small mammals such as the rock vole (Microtus chrotorrhinus) and the long-tailed shrew (Sorex dispar) may occur in boulder piles in these forests.

EXAMPLES

Great Smoky Mountains National Park, Swain and Haywood counties
Joyce Kilmer-Slickrock Wilderness, Nantahala National Forest, Graham County
Middle Creek Research Natural Area, Pisgah National Forest, Yancey County
Rendezvous Mountain State Forest, Wilkes County
White Oak Stamp, Standing Indian Mountain, and Black Mountain/Parker Knob, Nantahala National Forest, Macon and Jackson counties
Bluff Mountain, Ashe County

STATEWIDE STATUS

Oak-dominated forests in general are common in the eastern United States, but it is unclear how far particular community types in this theme extend beyond North Carolina. In North Carolina they have declined less than most communities. All but Montane White Oak Forest are common in the mountains. Montane Oak--Hickory Forest is perhaps the most abundant community type in the southern mountains, and High Elevation Red Oak Forest is the most common on the higher mountains. A fairly large number of each on public lands are Registered Natural Heritage Areas. Chestnut Oak Forest is the most common community type on the dry parts of the escarpment. Several examples are registered. Many of the registered examples, however, were protected incidentally as buffer for other community types. It is unlikely that all variants are protected, and there may be many better, but unprotected, examples.

INVENTORY NEEDS

Because they are common and many examples are protected, montane oak forests in general are a relatively low priority for basic inventory. Montane White Oak Forests appear to be fairly rare and are a moderate priority. More information is needed on the variation within the broad community types, and work is needed on defining variants and finding old-growth examples. Surveys of native moths and butterflies are needed to assess the potential future effects of gypsy moths, which attack oaks in particular.

MANAGEMENT ISSUES

Chestnut Blight: There is currently no effective control of the chestnut blight fungus. Surviving root systems produce sprouts which survive a few years before succumbing, but these seldom reach flowering age. Suitable control of the fungus, if found, should be applied to natural areas. If resistant stock of American chestnut is developed, consideration should be given to attempts to introduce it, but this will need to be weighed against the potential disruption of existing communities.

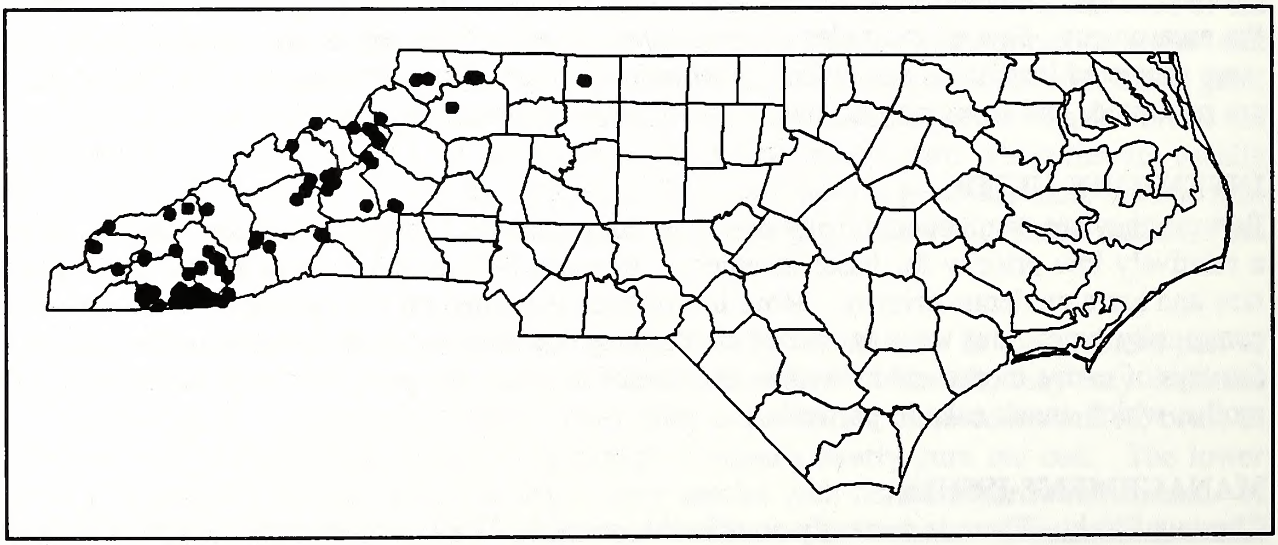
Fire: The natural fire regime of these communities is not known. They undoubtedly burned periodically due to lightning. Historical references suggest that they were burned by the Native Americans and later by European settlers. The degree to which fire is needed to maintain long term ecological structure and function is not known.

LONG TERM GOALS

While most of this theme is common and many examples are protected, much protection has been incidental. In the long term, protection efforts should focus on good geographic representation, representation of the rarer variants, and protection of old-growth and unusually large contiguous examples.

TWO YEAR PLAN

In 1993-1995, the Natural Heritage Program will conduct an inventory in one or more ranger districts in the mountain national forests. These inventories will explore poorly known areas with potential for these communities. An inventory in the South Mountains will also cover areas with potential for montane oak forests. The potential for registry of several examples of this theme on U.S. Forest Service lands will be explored during this period.



Recorded Occurrences of Montane Oak Forests

PIEDMONT AND COASTAL PLAIN OAK FORESTS

COMMUNITY TYPES

Piedmont Monadnock Forest
Dry Oak--Hickory Forest
Dry-Mesic Oak--Hickory Forest
Basic Oak--Hickory Forest
Xeric Hardpan Forest

GENERAL DESCRIPTION

Oak forests were once the most common natural community type in the Piedmont, occurring over most of the uplands. In the Coastal Plain they were much more limited, occurring primarily in dissected areas near streams. Although traditionally called oak--hickory forests, oaks are by far the predominant genus. Hickories are the second genus in terms of number of species, but tulip poplar or other species may be more abundant. Pines dominate severely disturbed examples, but probably were a minority component under natural conditions.

Dry-Mesic Oak--Hickory Forest and Dry Oak--Hickory Forest are the most typical of the five community types, occurring on upland slopes and ridgetops on acidic soils. White oak is usually the most abundant tree in both. Post oak and southern red oak are the primary associates in Dry Oak--Hickory Forests and red oak and black oak in Dry-Mesic Oak--Hickory Forests. Piedmont Monadnock Forests, typically dominated by chestnut oak and scarlet oak, occur on scattered hills which are resistant to the erosion affecting the surrounding land. They are sometimes regarded as disjunct examples of the mountain Chestnut Oak Forest, but they apparently were not codominated by American chestnut in the past, and they lack many of the other montane species. Basic Oak--Hickory Forests occur on upland flats and slopes in sites similar to Dry and Dry-Mesic Oak--Hickory Forests, but with soils that are not acidic. Most of the soils are apparently near neutral pH rather than strongly basic. They usually occur over mafic rocks such as gabbro and diabase. They are dominated by white oak in combination with hickories and post, red, or black oaks. A number of understory, shrub, and herb species that are scarce or absent on acidic soils are present, and characteristic acid-loving species such as blueberries are generally absent.

Xeric Hardpan Forests are the most distinctive of the Piedmont and Coastal Plain oak forests. They occur on flat to gently sloping uplands with clay hardpans that restrict water and root penetration. This situation is most common on mafic rocks, but it also occurs on acidic shales. These sites may have shallow standing water in wet seasons, but they are extremely dry in dry seasons. The canopy is dominated by some of the most drought tolerant trees in the state, post oak and blackjack oak, and is often somewhat open. While dense brush often occurs beneath the open canopy, these communities were probably once open and grassy beneath. Several plant species that need full sunlight are now present in openings and along adjacent roadsides. Historical reports describe some of these areas as actual treeless prairies, while others may have been open grassy savannas. Bison once were present in these areas. The interaction of the unusual soils with fire was almost certainly what produced the open aspect. No open prairies are known to remain in North Carolina, but several old pasture sites have vegetation that may represent recoverable remnants.

RARE SPECIES

A large number of rare plant species are associated with the Xeric Hardpan Forest and Basic Oak--Hickory Forest types. Most, such as smooth coneflower (Echinacea laevigata), Earle's blazing star (Liatris squarrulosa), hoary puccoon (Lithospermum canescens), and prairie dock (Silphium terebinthinaceum), are related to species of the midwestern prairies and occur only in openings. Other rare plants, such as Schweinitz's sunflower (Helianthus schweinitzii), Georgia aster (Aster georgianus), and Piedmont indigo-bush (Amorpha schwerinii), also need open sites but are less tightly associated with basic soils. Only a few rare plants, such as nestronia (Nestronia umbellula), occur in shady closed forests. Few rare animals are known to be tightly associated with these communities, but oak forests form a major part of the habitat of most wide-ranging animals.

EXAMPLES

Caswell Game Land, Caswell County
William B. Umstead State Park, Wake County
Eno River State Park, Orange and Durham counties
Morrow Mountain State Park, Stanly County
Duke Forest, Orange County
Uwharrie National Forest, Montgomery County

STATEWIDE STATUS

Dry-Mesic Oak--Hickory Forest is abundant throughout the Piedmont and is widespread, though not common, in the Coastal Plain. Many small to medium sized examples are protected, many incidental to the protection of other features. Given the former dominance of this community type over large areas, however, it has probably been reduced more from presettlement times than most community types. No large examples unfragmented by fields or successional vegetation remain, and there are few older examples. Dry Oak--Hickory Forests are much less common. More of the flat upland ridgetops where they usually occur have been farmed or developed. Mature Coastal Plain examples of both of these two types are much rarer than Piedmont examples. Several small examples are protected.

Basic Oak--Hickory Forests, Xeric Hardpan Forests, and Piedmont Monadnock Forests were always a minority of the vegetation because of their specialized sites. The rocky monadnocks escaped much of the early farming, though development, clearcutting, and other alterations have eliminated the natural character of some. A number of examples are protected. Xeric Hardpan Forests are less desirable than most sites for farming and development, but nevertheless many were lost in this way. Only a couple of small examples of this community type are protected.

INVENTORY NEEDS

The rarer Piedmont and Coastal Plain oak forests, Xeric Hardpan Forest and Basic Oak--Hickory Forest, are a high priority for inventory. Piedmont Monadnock Forests are better known than most communities, but some parts of the Piedmont are poorly known. Dry-Mesic and Dry Oak--Hickory Forests are considered a low priority for inventory because they are common, but knowledge of many areas is limited and there is a need to find representatives in many geographic areas.

MANAGEMENT ISSUES

Fire: Fire is believed to have been a natural part of all Piedmont and Coastal Plain oak forests, but its frequency and importance is not known. The restriction of oak forests in the Coastal Plain to fire-sheltered sites suggests a need for fires to be less frequent than in the longleaf pine communities that occupied the uplands. The Xeric Hardpan Forests appear to have changed the most with removal of fire, but fire probably had similar, if less dramatic, effects on the other communities, making them more open and grassy. Fire may have helped favor oaks over thin-barked, more moisture loving species. Regular fires also would have reduced fuel loads and reduced the potential for catastrophic canopy-killing fires.

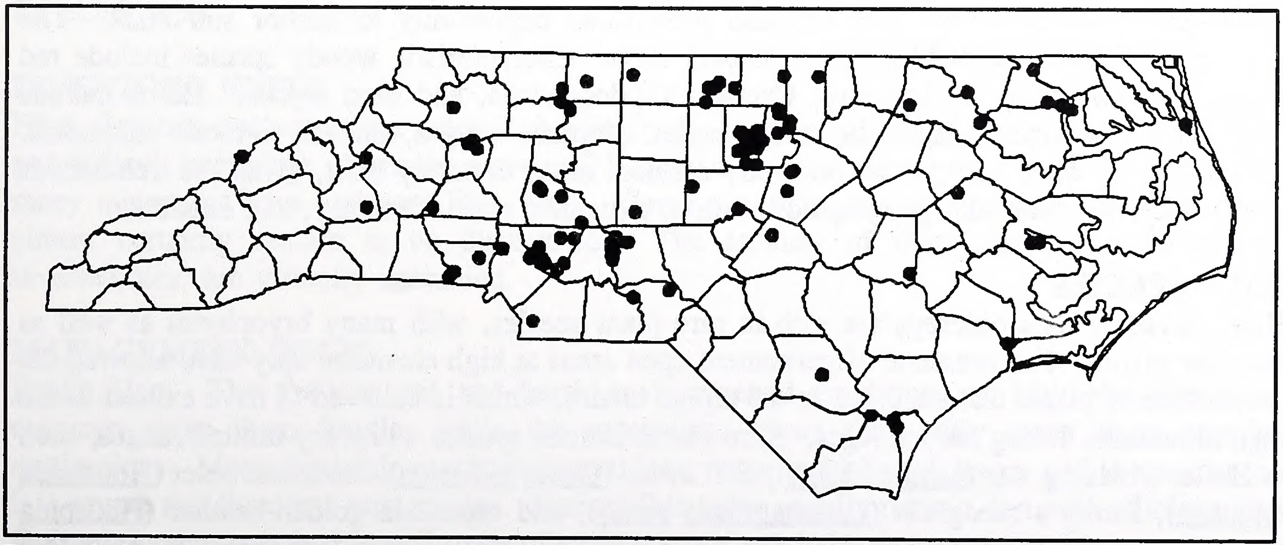
Fragmentation: As with other formerly widespread community types, fragmentation is a concern. Some species, particularly animals, may only be able to persist in large areas, or they may be excluded from areas near the forest edge. The chances for some of these animals to survive may be enhanced by protecting forested connections between larger forested blocks.

LONG TERM GOALS

More protected examples of all community types are needed. Xeric Hardpan Forests in particular are poorly protected. For the more common Dry-Mesic and Dry Oak--Hickory Forests, protection should focus on larger blocks, on unusually mature examples, and on geographic areas with few protected examples.

TWO YEAR PLAN

An inventory focused on Xeric Hardpan Forests and Basic Oak--Hickory Forests is in progress and will be completed in 1993-1995. The Natural Heritage Program is also conducting inventories of several Piedmont counties which will identify high quality examples of these communities.



Recorded Occurrences of Piedmont and Coastal Plain Oak Forests

HIGH ELEVATION ROCK OUTCROPS

COMMUNITY TYPES

High Elevation Rocky Summit
High Elevation Granitic Dome

GENERAL DESCRIPTION

High elevation rock outcrop communities occur on ridgetops, peaks, and upper slopes where soils are thin and discontinuous and rock dominates the surface. Even in the most rugged high mountains they represent only a small minority of the landscape. The vegetation is very patchy, reflecting the variability of the soil. The two community types differ in the structure of the rock surface and in associated vegetational composition and dynamics. High Elevation Granitic Domes occur on the exfoliated outcrops that form when massive granitic rock breaks off in sheets parallel to the surface. Exfoliation produces smooth dome-shaped outcrops that lack crevices. Lichens and mosses occur on the bare rock. Soil and vegetation develop together on the rock surface as moss mats gradually deepen and are invaded by a succession of herbs. Typical species include selaginella, mountain and spike oatgrass, sedges, mountain dandelion, and Michaux's saxifrage. Woody plants such as mountain laurel, Catawba rhododendron, and table mountain pine occur on the deeper soil mats and around the edges. The mats are not anchored to the rock below and eventually fall off or are pulled up by falling trees, leaving the rock bare again. The shallow soils are generally dry, but some zones of seepage are usually present on the edge of the soil of adjacent forests. A number of wetland plants can occur in these saturated areas.

High Elevation Rocky Summit communities occur on fractured rock. The bare rock is similarly vegetated by patches of lichen and moss, and shallow soil mats may develop locally. The presence of fractures, however, offers patches of deeper, more permanent soil that can support more deeply rooted plants, and that can provide an opportunity to anchor soil mats. The vegetation pattern is less likely to shift over time. Characteristic woody species include red spruce, yellow birch, serviceberry, Catawba rhododendron, and sand myrtle. Herbs include Michaux's saxifrage, selaginella, crag jangle, oatgrass, sedges, and three-tooth cinquefoil. Although only three variants are currently defined, many certainly exist, given the tremendous community variation with geographic location, structure, rock chemistry, and exposure.

RARE SPECIES

High elevation rock outcrops are rich in rare plant species, with many bryophytes as well as vascular plants. The presence of permanent open areas at high elevation may have allowed the persistance of plants that occurred in the alpine tundra, which is believed to have existed in the high mountains during the Ice Ages. Rare plants include species with very limited ranges, such as Heller's blazing star (Liatris helleri), cliff avens (Geum radiatum), mountain bluet (Houstonia montana), Porter's reedgrass (Calamagrostis cainii), and mountain golden-heather (Hudsonia montana). Northern disjunct species such as deerhair bulrush (Scirpus cespitosus), fir clubmoss (Huperzia selago), and Greenland sandwort (Minuartia groenlandica), and southern species such as wretched sedge (Carex misera) and pink-shell azalea (Rhododendron vaseyi), also occur. High Elevation Granitic Domes contain some of the same rare species, such as wretched sedge, as well as some characteristic species of their own, such as divided-leaf ragwort (Senecio millefolium) and Biltmore sedge (Carex biltmoreana). Rare animals are probably few, but the poorly studied invertebrate groups may contain many rare species. Peregrine falcons (Falco peregrinus) nested on high elevation rock outcrops in the past and are being reintroduced at several such places. Green salamanders (Aneides aeneus) and other crevice-dwelling animals may also occasionally occur.

EXAMPLES

Grandfather Mountain, Avery and Watauga counties
Roan High Bluff, Pisgah National Forest, Mitchell County
Bluff Mountain, Ashe County
Mount Jefferson State Park, Ashe County
Craggy Pinnacle, Blue Ridge Parkway and Pisgah National Forest, Buncombe County
Table Rock Mountain and Hawksbill, Linville Gorge, Pisgah National Forest, Burke County
Devil's Courthouse, Blue Ridge Parkway, Transylvania County
Looking Glass Rock, Pisgah National Forest, Transylvania County
Whiteside Mountain, Nantahala National Forest, Jackson County
Panthertown Valley, Nantahala National Forest, Jackson County

STATEWIDE STATUS

High elevation rock outcrops are naturally rare because of their specialized sites. High Elevation Granitic Domes are largely limited to the area around the towns of Highlands and Cashiers, with only a few scattered examples elsewhere. High Elevation Rocky Summits are scattered through the higher mountains but represent very little acreage. Many variants are very rare. These communities have been less often destroyed than most, but recreational development and heavy public use have degraded some and threaten others. Several domes and a number of rocky summits are under protective designation, but these alone do not represent adequate protection for either type.

INVENTORY NEEDS

High elevation rock outcrops are a high priority for inventory. They are usually inaccessible and difficult to explore. Even the more well known and visited sites have unexplored areas, and many mountains have had very little work. Some new sites and many rare plant populations almost certainly remain to be discovered. The animals of these sites, particularly the invertebrates, are virtually unstudied.

MANAGEMENT ISSUES

Public Use: The shallow soil and harsh environmental conditions of high elevation rock outcrops make them fragile, while the spectacular views they offer make them popular destinations. Most accessible outcrops have at least some trampling damage, and in some cases it is severe and threatens rare species. Inaccessible areas usually remain, but rock climbers and their equipment can threaten all parts of an outcrop if use is heavy.

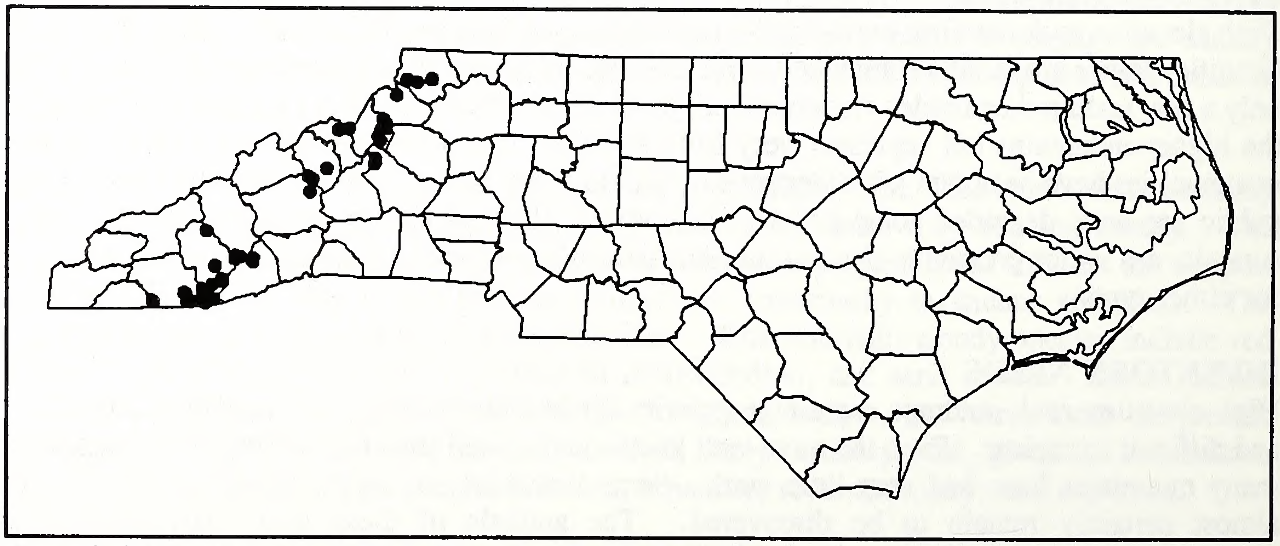
Fire: In at least one variant, the Quartzite Variant in Linville Gorge, fire has been demonstrated to be an important dynamic factor, controlling shrub patterns and competition on the edges of outcrops. Most rock outcrop communities do not appear to be very prone to fire, but the slow growth of vegetation may make even rare fires an important influence.

LONG TERM GOALS

Better understanding is needed of the variants of these communities. Because of their rarity, essentially all examples should be protected.

TWO YEAR PLAN

In 1993-1995, the Natural Heritage Program will conduct inventories on one or more ranger districts in the mountain national forests. Attempts will be made to inventory several privately owned sites that are known or believed to contain high quality rock outcrops. The Natural Heritage Program will support protection efforts on several high priority high elevation rock outcrop sites.



Recorded Occurrences of High Elevation Rock Outcrops

LOW ELEVATION CLIFFS AND ROCK OUTCROPS

COMMUNITY TYPES

Low Elevation Rocky Summit
Low Elevation Granitic Dome
Montane Acidic Cliff
Montane Calcareous Cliff
Montane Mafic Cliff
Piedmont/Coastal Plain Acidic Cliff
Piedmont Calcareous Cliff
Piedmont Mafic Cliff
Piedmont/Coastal Plain Heath Bluff

GENERAL DESCRIPTION

This broad theme contains a wide variety, though not all, of the community types that are too steep or rocky to support a closed tree canopy. The vegetation of these communities is generally very patchy, reflecting extreme variability in the depth and composition of soil and of available moisture. Plants include forest species with broad site tolerances, species characteristic of a wide range of open habitats, and species specialized for rock outcrops. Rock outcrops typically are very dry, but seepage zones are often present and may support wetland vegetation. The nine natural community types are separated based on rock chemistry, topographic location, and geographic region, and the latter is an important factor in determining flora.

Like their high elevation counterparts, Low Elevation Rocky Summit and Low Elevation Granitic Dome communities occur in exposed positions on peaks, ridgetops, and upper slopes. Most are in the Mountain region, but a few examples occur in the upper Piedmont. Low Elevation Granitic Domes occur on exfoliated outcrops of granitic rock, where peeling of sheets of rock parallel to the surface produces a dome-shaped outcrop of solid rock. Soil mats that begin as moss clumps gradually thicken over time and follow a characteristic vegetational succession from herbs to shrubs and stunted trees. The unanchored mats are periodically destroyed by falling off or by being pulled up by falling trees, leaving the rock bare and beginning the succession anew. Low Elevation Rocky Summits, in contrast, have fractured rock which allows growth of deep-rooted woody plants in places. Soil accumulates in pockets of varying depth and produces heterogeneous vegetation. Many variants potentially occur, but are not well known.

Cliff communities occur on lower, more sheltered topographic sites. They generally are created by streams undercutting a bluff, but they may occur above a stream. Like Rocky Summits, the rock is usually fractured and supports patchy vegetation that includes woody plants rooted in crevices as well as herbs in soil pockets and mosses and lichens on bare rock. The Montane and Piedmont/Coastal Plain types have flora typical of their regions, often combining plants from adjacent communities with typical outcrop plants. North-facing cliffs have a cooler microclimate than the surrounding areas and sometimes harbor disjunct or regionally rare species characteristic of cooler, moister regions. In some cases these species are believed to be remnants from more widespread populations that existed in the Ice Ages. In the Mountain region, south-facing cliffs may support species more typical of the warmer Piedmont or even Coastal Plain.

The Acidic, Mafic, and Calcareous types support different flora that reflect the rock chemistry. Mafic and Calcareous cliffs contain calcium-loving and magnesium-loving species that do not occur on the more common Acidic cliffs. The floristic differences between Calcareous and Mafic cliffs are more subtle, and reflect differences in the composition of the rocks.

Piedmont/Coastal Plain Heath Bluffs differ somewhat from the other community types in that they have little bare rock. They do, however, lack a closed tree canopy, apparently because of steepness. They are characterized by a dense shrub layer of mountain laurel or Catawba rhododendron, which are otherwise essentially absent in the Piedmont and Coastal Plain. These communities occur on north-facing bluffs, and the cool microclimate is believed to be important to these species.

RARE SPECIES

The community types in this theme support a moderate number of rare plant species. Some species, such as Greenland sandwort (Minuartia groenlandica) and divided-leaf ragwort (Senecio millefolium), are shared with the high elevation rock outcrop communities. A few highly restricted species, such as Keever's bristle moss (Orthotrichum keeverae), occur, along with more widespread species of specialized sites such as Bradley's spleenwort (Asplenium bradleyi), and disjunct species such as dwarf juniper (Juniperus communis var. depressa).

Mafic and Calcareous Cliff communities support a number of calcium-loving species which are rare in North Carolina, including shooting star (Dodecatheon meadia), prairie ragwort (Senecio plattensis), southern thimbleweed (Anemone berlandieri), Missouri rockcress (Arabis missouriensis), Alabama lip-fern (Cheilanthes alabamensis), and cliff stonecrop (Sedum glaucophyllum). Acidic Cliffs contain a smaller but still moderate number of rare plants. Some are outcrop plants shared with the Mafic and Calcareous types, such as Carey's saxifrage (Saxifraga careyana) and Carolina saxifrage (Saxifraga caroliniana). Others are apparently acid-loving plants such as Bradley's spleenwort, piratebush (Buckleya distichophylla), Oconee bells (Shortia galacifolia), dwarf filmy-fern (Trichomanes petersii), and many bryophytes. Many of the plants in all of these categories are limited to small parts of the state or occur on only a few outcrops.

Rare animals are generally not well known. Crevice-dwelling species such as the green salamander (Aneides aeneus) may occur. Peregrine falcons (Falco peregrinus) may use the rocky summits, as may ravens (Corvus corax). Some examples may contain disjunct or relict invertebrates. There is high potential for rare invertebrates associated with the specialized habitats and distinctive flora of these communities.

EXAMPLES

Hanging Rock State Park, Stokes County
Pilot Mountain State Park, Surry County
Crowders Mountain State Park, Gaston County
Stone Mountain State Park, Wilkes and Alleghany counties
William B. Umstead State Park, Wake County
Eno River State Park, Orange and Durham counties

Raven Rock State Park, Harnett County
Cliffs of the Neuse State Park, Wayne County
Linville Gorge, Pisgah National Forest, Burke County
Linville Caverns, McDowell County
Joe-Little Joe Mountains, Alexander County
Grandfather Mountain, Avery and Watauga counties
Bluff Mountain, Ashe County
White Oak Mountain-Tryon Peak, Polk County
Rocky Ford Creek Mountain Laurel Bluff, Sandhills Game Land, Richmond County

STATEWIDE STATUS

Low elevation rock outcrops have generally escaped the widespread destruction and alteration of other natural communities, though development, mining, and heavy trampling have destroyed or heavily altered some and threaten others. While none of these community types make up more than a tiny fraction of the landscape, the Acidic Cliffs and Piedmont/Coastal Plain Heath Bluff are fairly widespread and have several examples protected. Low Elevation Rocky Summits and Low Elevation Granitic Domes are uncommon. Several examples of each are protected, though they do not adequately protect all of the diversity within these community types. Piedmont Mafic Cliff and Piedmont Calcareous Cliff communities are extremely rare in North Carolina, with only a couple of examples known and only one protected. Montane Calcareous Cliffs and Montane Mafic Cliffs are similarly very rare and have only two protected examples.

INVENTORY NEEDS

Low elevation rock outcrops are a high priority for basic inventory, with the highest priority for the rarest types. More information is also needed for understanding the variation in these communities.

MANAGEMENT ISSUES

Public Use: The thin soils make these communities fragile while the open views they often offer make them attractive to people. Examples with easy public access are often heavily trampled. Trampling is generally concentrated on the flatter upper portions, which typically support the most vegetation. While most examples have some inaccessible areas, rock climbers and their equipment may disturb all parts of popular climbing areas. Structures built to improve public safety at cliff edges also can be destructive of portions, though they may help limit damage on the rest of the site.

Exotic Species: The open nature of these communities makes them somewhat susceptible to invasion by exotic plants. The mafic and calcareous outcrop communities are particularly susceptible. Opening of the canopy in adjacent forests may change light levels of rock outcrops and make them more susceptible.

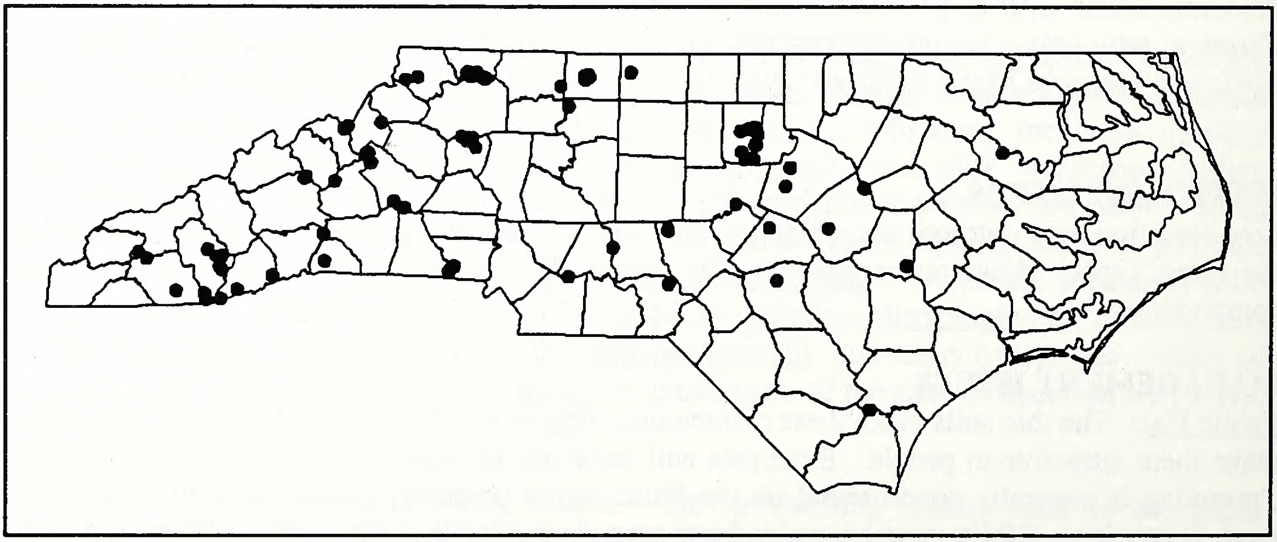
Fire: Most rock outcrops appear not to be prone to fire. Nevertheless, fire may be important in controlling woody plant dynamics in portions of some sites. Even rare fires may conceivably have important long term effects.

LONG TERM GOALS

Given their wide variability, more examples of the more common Piedmont/Coastal Plain Acidic Cliff, Piedmont/Coastal Plain Heath Bluff, and Montane Acidic Cliff types are in need of protection. Attention to these community types should emphasize examples that are part of larger contiguous natural areas, rare variants, or unusually high quality examples. For the rare community types, essentially all examples should be protected.

TWO YEAR PLAN

An inventory of natural communities associated with Piedmont mafic rocks, including Piedmont Mafic Cliffs, is currently in progress and will be completed in 1993-1995. Several county inventories planned or in progress across the state during this period will also cover areas with potential for these communities. Inventories will also be conducted on one or more ranger districts of the mountain national forests. Landowner contact and Natural Heritage Program assistance to other protection efforts for several high priority sites will be attempted.



Recorded Occurrences of Low Elevation Cliffs and Rock Outcrops

COASTAL PLAIN MARL OUTCROP

COMMUNITY TYPES
Coastal Plain Marl Outcrop

GENERAL DESCRIPTION
This theme is rather narrowly defined and is very rare. Coastal Plain Marl Outcrop communities occur on the rare outcrops of limestone on the Coastal Plain. Some are true marl while others are coquina or other kinds of limestone. Outcrops are located along stream bluffs or in ravines where recent exposures have not yet been covered by soil or weathered. One unique outcrop is maintained by waves on the north shore of Lake Waccamaw. While they are in some senses a counterpart to the Piedmont Calcareous Cliff community type, Coastal Plain Marl Outcrops generally are shaded by trees. The trees, rooted in soil pockets or in adjacent forests, include calcium-loving species such as black walnut, sugar maple, and pawpaw, as well as more widespread moisture loving species such as beech and tulip poplar. Poison ivy and Virginia creeper vines often run over the bare rocks. Characteristic limestone herbs include ebony spleenwort, wild ginger, bloodroot, columbine, and several mosses.

RARE SPECIES
Several rare plant species specialized for limestone occur in these communities, including Venus hair fern (Adiantum capillus-veneris), Carolina spleenwort (Asplenium heteroresiliens), Tennessee bladder fern (Cystopteris tennesseensis), Godfrey's sandwort (Minuartia godfreyi), and rockcress (Arabis lyrata). There is potential for rare invertebrates to occur.

EXAMPLES
Island Creek, Croatan National Forest, Jones County
Walkers Bluff, Bladen County
Shell Landing, Craven County
Lake Waccamaw north shore, Columbus County

STATEWIDE STATUS
Coastal Plain Marl Outcrops are very rare in North Carolina. Only ten examples are known, and only a few more are likely to be discovered. These natural communities generally occur along stream bluffs, where they have not been subject to clearing or timbering, but development and clearing of adjacent forests may threaten them. Mining of limestone is also a potential threat. Four sites have at least some protection.

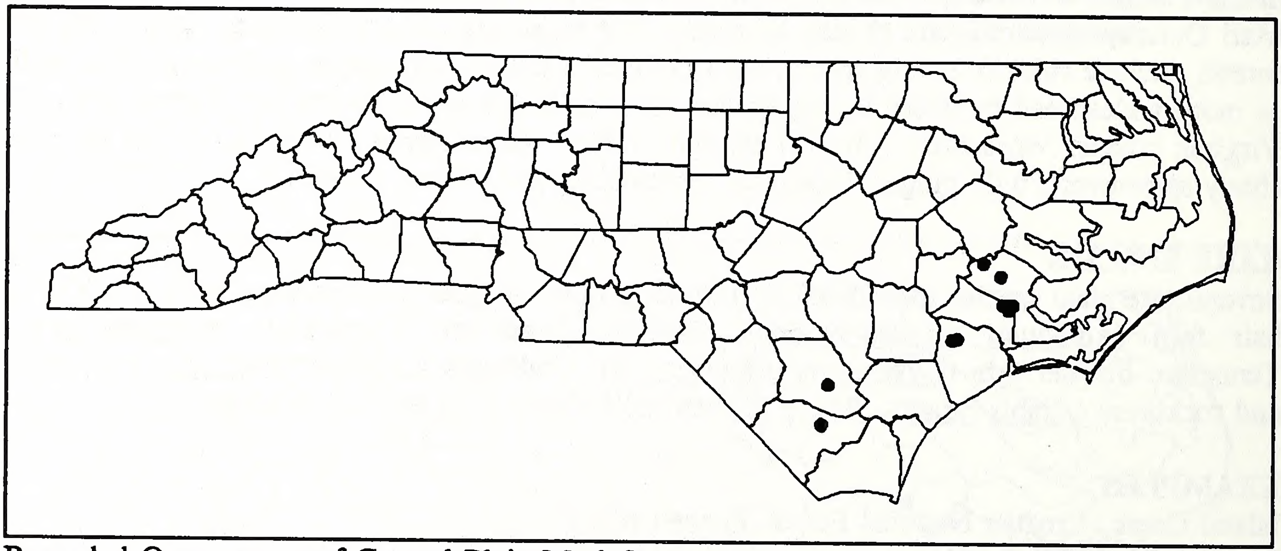
MANAGEMENT ISSUES
Exotic Species: Coastal Plain Marl Outcrops are fairly susceptible to invasion by exotic plants, because of the somewhat open vegetation and rich soils. Japanese honeysuckle is often dense and spreads out over the open rock. Opening of the canopy in adjacent forests is likely to encourage invasion.

LONG TERM GOALS

Because of their rarity, essentially all examples ideally should be protected. Sites are small and generally not highly desirable for other uses.

TWO YEAR PLAN

Natural Heritage Program inventories in Brunswick and Columbus counties have some potential for finding additional examples. Landowner contact to encourage protection may be attempted at one or more high priority sites.



Recorded Occurrences of Coastal Plain Marl Outcrops

GRANITIC FLATROCKS

COMMUNITY TYPES

Granitic Flatrock

GENERAL DESCRIPTION

Granitic Flatrock communities occur on flat to gently sloping exfoliated outcrops of granitic rocks in the Piedmont. They are scattered along the Piedmont from Virginia to Alabama. The rock outcrop is generally flush with the surrounding soil and has only minor irregularities. These communities are somewhat related to the Granitic Dome communities of the upper Piedmont and Mountains. Like them, the vegetation of the flatrocks is sparse and very patchy. On bare rock, soil mats that accumulate in moss clumps undergo a gradual development, deepening and being invaded by a succession of plants.

A number of characteristic plants, some found in no other communities, occur on flatrocks. Typical species include rock spikemoss, Small's portulaca, sandwort, ragwort, elf orpine, and talinum. A number of species are also shared with eroded old fields, including broomsedge, buttonweed, and ragwort. Deeper soils may support woody species such as eastern red cedar, Virginia pine, and fringe tree. Developing soil mats are apparently periodically pulled up by uprooted trees, recreating open bare rock surface and allowing the flatrock to maintain itself in the long term. Small depressions in the rock surface hold water in the winter but become dry in summer. They contain their own characteristic specialized flora, including Piedmont quillwort, bladderwort, and peat moss. More permanently wet areas occur in seepage zones at the edge of adjacent soils.

RARE SPECIES

Several rare plant species are confined to flatrocks, including elf orpine (Diamorpha smallii), Piedmont quillwort (Isoetes piedmontana), Alabama sandwort (Minuartia alabamensis), single-flowered sandwort (Minuartia uniflora), Small's portulaca (Portulaca smallii), and Puck's orpine (Sedum pusillum).

EXAMPLES

Mitchell's Millpond State Natural Area, Wake County
Overton Rock Outcrop, Franklin County
The Rocks, Wake County
Martin's Rock, Anson County

STATEWIDE STATUS

Granitic Flatrocks in North Carolina are primarily in two clusters, one in eastern Wake and Franklin counties, the other in Anson County. Only a few examples occur elsewhere. While the rocks escaped the widespread clearing and farming in the Piedmont and a high proportion remain, some have been destroyed and many have been damaged by mining, vehicle use, trash dumping, and other activities. Two excellent examples and several other good examples in the eastern cluster are protected as Registered Natural Heritage Areas. Only one well-developed example occurs on public land. Most good examples are unprotected.

INVENTORY NEEDS

The recently completed Albemarle/Pamlico Estuarine Study inventory covered the Wake-Franklin County cluster area and found several new sites. Some of these areas need followup inventory. The Anson County cluster received some inventory work years ago and needs rechecking. Examples away from the known clusters are difficult to find. Inventories of moths, butterflies, and other insects associated with these communities are needed.

MANAGEMENT ISSUES

Unauthorized Use: The flat open rock surface of flatrocks makes them attractive to off-road vehicle users and even to driving and parking of ordinary cars. They also invite trash dumping, and most have at least some trash piles.

Public Use: While less destructive than vehicles, heavy foot traffic can seriously damage soils and vegetation. Shallow soils and harsh conditions for plants make these communities fragile.

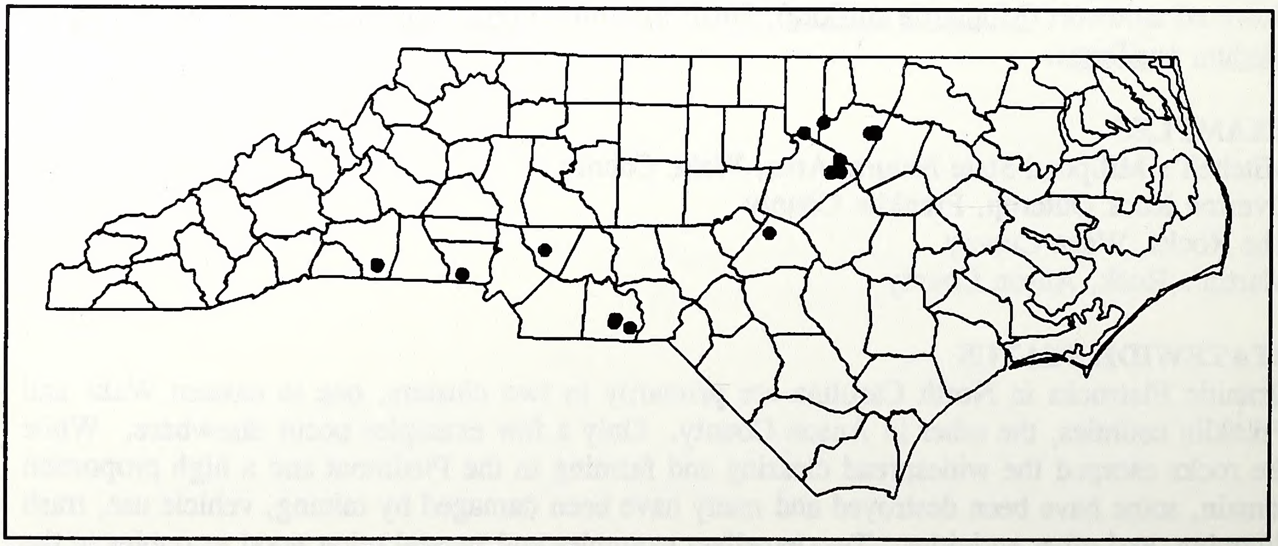
Relation to Adjacent Communities: Little is known about the relationship of Granitic Flatrocks to adjacent natural communities. The seepage areas on the edges of many flatrocks are fed by water from adjacent forest soils, and may be hydrologically altered if land is cleared or heavily disturbed. Most animal species probably are shared with the adjacent forests.

LONG TERM GOALS

Many more examples of these rare communities are in need of protection. Given their rarity, almost all well-developed examples ideally should receive some form of protection.

TWO YEAR PLAN

No inventories planned in 1993-1995 are very likely to find new Granitic Flatrock sites. Landowner contact to seek voluntary protection will be attempted on several high quality sites.



Recorded Occurrences of Granitic Flatrocks

MAFIC GLADES AND BARRENS

COMMUNITY TYPES

High Elevation Mafic Glade
Diabase Glade
Ultramafic Outcrop Barren

GENERAL DESCRIPTION

The communities in this theme are non-forested communities that have in common occurrence on relatively flat outcrops of unusual, high pH rock types. All have vegetation kept open by the physical structure and chemistry of the rock. All are characterized by unique combinations of widespread plant species as well as by rare species.

Ultramafic Outcrop Barrens occur on dunite, peridotite, or serpentinite. These rocks are associated with unusual vegetation and endemic species throughout the world because of their unusual chemistry. North Carolina's only well-developed Ultramafic Outcrop Barren is an open savanna-like community with a scattered pitch pine canopy and grassy ground cover. Among the dominant grasses is prairie dropseed, which occurs nowhere else in the state. Other dominants are little bluestem, big bluestem, and panic grasses.

The single known High Elevation Mafic Glade community occurs on a flat exposure of amphibolite in Ashe County. Lichens, including a species found nowhere else (Cladonia psoromica), dominate much of the area. Herbs on thin soil mats and in crevices include lowland species such as stiff-leaved aster, little bluestem, and pineweed, as well as northern disjunct species such as three-tooth cinquefoil. Woody species occur in deeper soils and crevices.

Diabase Glades occur in the Piedmont over outcrops of diabase and potentially other mafic rocks. As with other glade communities, the soil and vegetation are patchy and range from nearly bare rock to patches deep enough to support trees. The vegetation includes many species shared with other high pH soil communities, such as eastern red cedar, leather-flower, smooth coneflower, columbine, dwarf hackberry, buckbrush, fragrant sumac, and barberry. It also includes species shared with Granitic Flatrocks, such as buttonweed, agave, Small's portulaca, and fameflower. A number of more widespread open site species, such as little bluestem and prickly pear cactus, are also present.

RARE SPECIES

All three communities have high concentrations of rare plant species. The rarest is a lichen (Cladonia psoromica), known from only one site in the world. Most others are associated with related rare communities throughout their range. Examples include fringed gentian (Gentianopsis crinita), large-leaved grass of parnassus (Parnassia grandifolia), hoary puccoon (Lithospermum canescens), prairie dock (Silphium terebinthinaceum), smooth coneflower (Echinacea laevigata), prairie goldenrod (Solidago ptarmicoides), and serpentine aster (Aster depauperatus). Disjunct species, rare in North Carolina but common elsewhere, also occur. Prairie dropseed (Sporobolus heterolepis) is perhaps the most dramatic example. Occurrences of animals in glades and barrens are generally not known. There is high potential for rare invertebrates, perhaps even new species, associated with these unusual communities.

EXAMPLES

Bluff Mountain, Ashe County
Buck Creek Serpentinized Olivine Barrens, Clay County
South Butner Cedar Glade, Durham County

STATEWIDE STATUS

All three community types are among the rarest in the state and are also rare globally. Only one example of a High Elevation Mafic Glade is known in the world. It is protected on a Nature Conservancy preserve. One well-developed Ultramafic Outcrop Barren community and a couple of marginally developed or damaged examples occur in the state. While ultramafic rock barrens occur more widely in other states, particularly Maryland, Georgia, and Alabama, it is unclear if they represent the same community type as those in North Carolina. The two North Carolina examples are both partially protected as Registered Natural Heritage Areas. One high quality Diabase Glade is known in North Carolina, along with one lower quality and several heavily altered examples. A single example in South Carolina is the only other known occurrence of this type. The best North Carolina example is registered.

INVENTORY NEEDS

The extreme rarity of these communities makes it difficult to search for them. All potential leads are very high priority for followup. Areas of mafic rocks also have high potential for other fairly rare community types and are a high priority for inventory. Surveys for insects in mafic glades and barrens are a fairly high priority.

MANAGEMENT ISSUES

Fire: While vegetational succession to forest is slowed on barrens and glades by the shallow, inhospitable soils, most related communities that have been studied have been found to need at least periodic fire to prevent ultimate takeover by woody vegetation. The slow growth may make even infrequent fires very influential on vegetation structure. It is not known if these communities in North Carolina need fire, but it is likely that at least the Diabase Glade and Ultramafic Outcrop Barren do need infrequent fire.

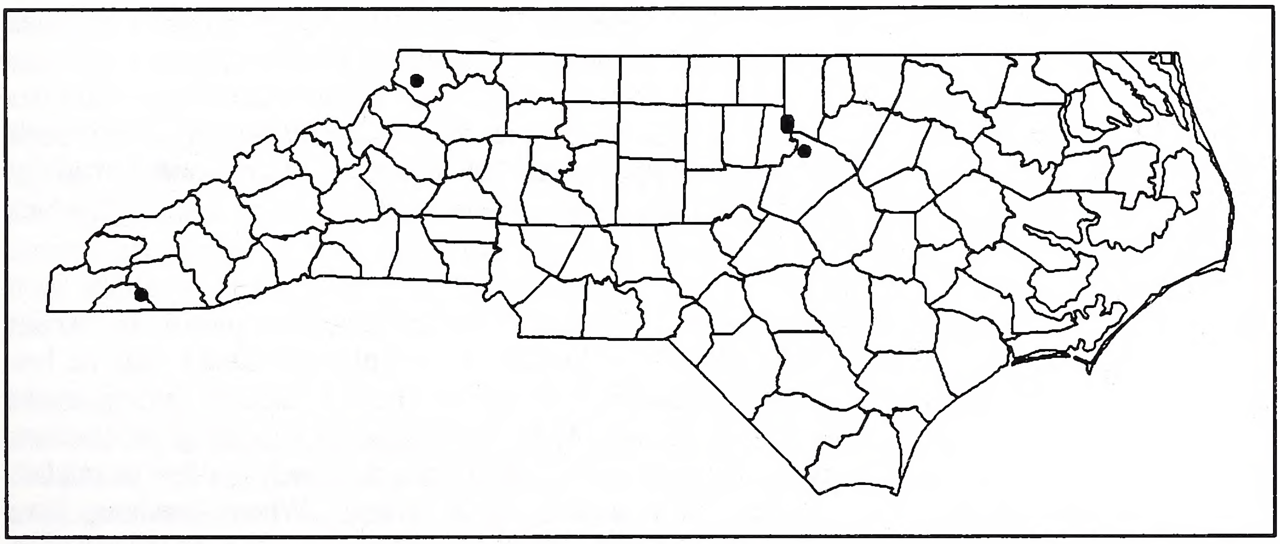
Public Use: None of the sites for these communities currently receive much public use. They do not offer views, but they are open and may be attractive to people. All are fragile and would be damaged by heavy trampling. Use by off-road vehicles is a major potential threat.

LONG TERM GOALS

Because of their extreme rarity, all known examples, even somewhat degraded ones, should be protected. These are among the highest priority communities in the state and contain some of the rarest species.

TWO YEAR PLAN

The inventory under way for communities asssociated with Piedmont mafic rocks will include searching potential sites for Diabase Glades. Inventory may be initiated in 1993-1995 for amphibolite areas in the northern mountains, which would include the potential for High Elevation Mafic Glade. Attempts at protecting more of the known sites will be pursued if opportunities become available.



Recorded Occurrences of Mafic Glades and Barrens

MARITIME GRASSLANDS

COMMUNITY TYPES

Dune Grass
Maritime Dry Grassland
Maritime Wet Grassland
Upper Beach

GENERAL DESCRIPTION

The communities in this theme all occur along the coast and are unable to support trees because of heavy salt spray or overwash by salt water during storms. Dune Grass communities occur on the line of foredunes just behind the beach and on unstable sand dunes farther back on barrier islands. The loose, shifting sand with its low water holding capacity and low nutrient reserves makes these environments habitable by only a handful of specialized plant species. Sea oats grass is the dominant plant in most examples, with American beach grass dominating examples in the northern part of the state. Artificial dune stabilization by planting grasses or placing snow fences modifies the natural dune structure and dynamics. The higher, more continuous artificial dunes are more susceptible to erosion on the front because there are no passages through which seawater can wash.

Maritime Dry Grassland communities occur on more stable sands in the interior of barrier islands. They may be on low, stable, old dunes, but are most typical on sandy flats on low islands that lack continuous foredunes. Seawater overwashes the low islands during severe storms and kills any invading woody vegetation. The characteristic dominant grass in these communities is saltmeadow cordgrass, though seaside little bluestem occurs in a few examples. A variety of other plants occur but the overall diversity is fairly low. Where foredunes have been artificially stabilized, overwash is stopped by the continuous dune line, and shrubs and trees are able to invade the sandy flats.

Maritime Wet Grasslands may occur on low sand flats or in dune swales where the water table is at or close to the surface for at least part of the year. Some examples may even be flooded for substantial periods. Seawater overwash is a factor in some examples. Saltmeadow cordgrass is generally dominant but a great diversity of other species is present. Common plants such as muhly grass and white-bracted sedge give these communities a beautiful and distinctive aspect.

The Upper Beach type is not technically a grassland, but is closely related to the other community types in this theme. It occurs above the mean high tide line behind the intertidal beach. The environment is very harsh for plants, with almost constant salt spray and with periodic flooding and reworking of sand during storms. A handful of mostly annual, salt-tolerant herbs occur as sparse patches and scattered individuals on the sand. They include sea rocket, dixie sandmat, seaside sandmat, Russian thistle, and seabeach amaranth. Small mounds of sand may develop around the few perennial plants, such as sea oats and marsh elder, forming the beginnings of dunes.

RARE SPECIES

Maritime grassland communities have a fairly low number of rare plant species, but several occur only here, including seabeach amaranth (Amaranthus pumilus), seabeach buckwheat (Polygonum glaucum), and dune bluecurls (Trichostema sp. 1). Loggerhead sea turtles (Caretta caretta) and occasionally other sea turtles nest in the Upper Beach. Piping plovers (Charadrius melodus) nest in colonies in specialized Upper Beach sites. Invertebrates are not well studied. Rare tiger beetles are associated with these communities in other states.

EXAMPLES

Shackleford Banks and Core Banks, Cape Lookout National Seashore, Carteret County
Ocracoke and Hatteras islands, Cape Hatteras National Seashore, Hyde and Dare counties
Hammocks Beach State Park, Onslow County
Bald Head Island State Natural Area, Brunswick County
Masonboro Island Estuarine Research Reserve, New Hanover County

STATEWIDE STATUS

Upper Beach communities occur continuously along the coast of North Carolina. Long stretches are public land, but most are subject to vehicle use. Dune Grass communities were once continuous along the coast, but many privately owned dunes have been developed. Artificial dune stabilization has been widespread and has altered most of the foredunes. Large stretches are in public ownership, and a few unstabilized islands are protected.

Maritime Dry and Wet Grasslands alternate with maritime forests as the dominant vegetation on the interior of barrier islands. Grasslands once were more abundant, but many have been developed. Vast areas of undeveloped grasslands, including much on public lands, have undergone unnatural succession to shrub dominance as a result of artificial dune stabilization. A few sizeable unaltered grassland islands remain. The abundance of Maritime Wet Grasslands is poorly known, and they may be fairly rare.

INVENTORY NEEDS

The distribution of this theme as a whole is naturally limited and is well known. Much inventory work was done in the past. The current status and condition of some examples is not known and is in need of monitoring. The locations and amounts of Maritime Wet Grassland are poorly known, and are in need of further investigation.

MANAGEMENT ISSUES

Succession: Unnatural succession has resulted from artificial dune stabilization in many examples of Maritime Dry Grassland. Because overwash damages roads and structures, it would be very difficult to reintroduce it. Some attempts have been made to control invading woody vegetation with fire. While this may create a similar appearance to natural grassland, it creates very different ecological dynamics and probably different species composition.

Vehicle Use: Use of off-road vehicles is widespread in the open vegetation of maritime grasslands. Most Upper Beach occurrences in the state and many Maritime Dry Grasslands are scarred by vehicle tracks. Recovery is rapid if vehicles are excluded from the naturally scoured Upper Beach, but is fairly slow in the other grassland communities. Vehicles are particularly harmful to nesting piping plovers and other colony-nesting birds. Colonies are often roped off during the nesting season to exclude vehicles.

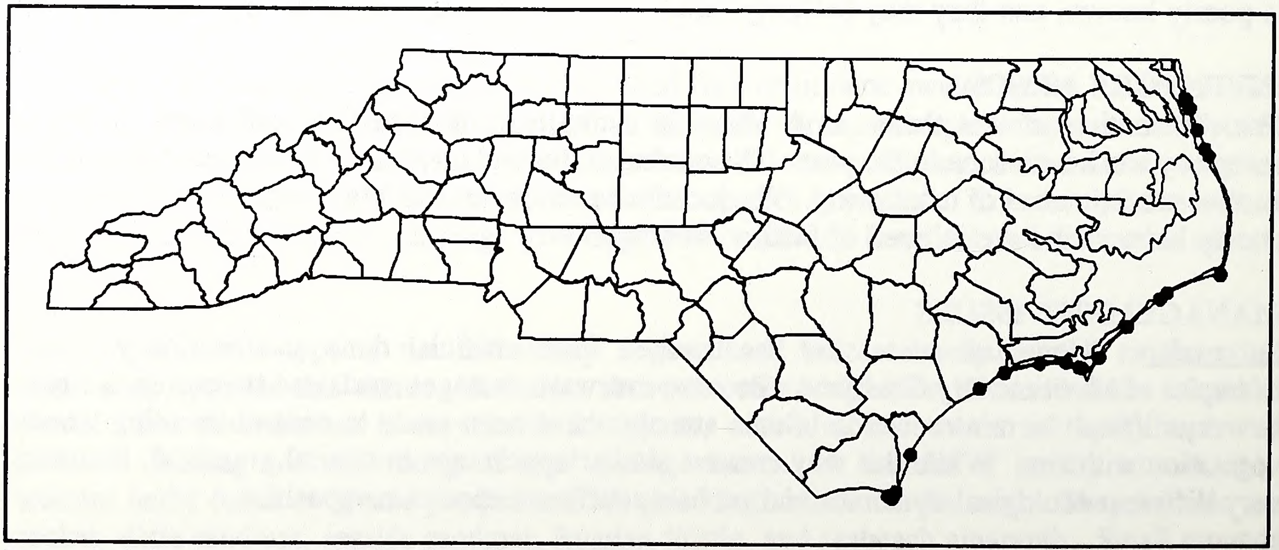
Beach Erosion: Barrier islands are naturally shifting environments. With global sea level slowly rising, islands apparently migrate shoreward naturally through the processes of overwash and dune migration, which transfer sand from the beach to the back of the island. On islands with artificially continuous dune lines, overwash is prevented and erosion is intensified. As developed islands erode, buildings and roads are threatened and pressure increases to prevent their loss. Artificial structures such as sea walls protect a section of the island interior but cause the beach to erode and cause erosion to accelerate elsewhere. Beach nourishment, putting additional sand onto the beach to replace erosional losses, is less destructive, but the long term ecological effects are not known.

LONG TERM GOALS

Given the scarcity of high quality examples of Maritime Dry and Wet Grassland, the few remaining unprotected high quality examples on small barrier islands should be protected. Where feasible, management should be changed to allow natural ecological dynamics in undeveloped examples on public lands. Existing protective agreements should be maintained.

TWO YEAR PLAN

A planned inventory of Brunswick County will examine the remnants of maritime grasslands in that part of the state. No other inventory activities in maritime grasslands are planned for 1993-1995. Registry or assistance with other forms of protection may be undertaken if the opportunity arises.



Recorded Occurrences of Maritime Grasslands

MARITIME UPLAND FORESTS

COMMUNITY TYPES

Maritime Shrub
Maritime Evergreen Forest
Maritime Deciduous Forest
Coastal Fringe Evergreen Forest

GENERAL DESCRIPTION

Woody vegetation on the barrier islands includes well-developed forests with canopies typically dominated by live oak, sand laurel oak, and loblolly pine; cabbage palms are a distinctive component in the Cape Fear area. It also includes the distinctive scrubby woody growth of stabilized sand dunes, dune swales, and sand flats. A few areas on the mainland shore of the sounds share the characteristic species of the barrier island maritime forests. The rare Maritime Deciduous Forests are dominated by beech, American holly, loblolly pine and hickory on the northern barrier islands. Maritime forests have relatively low species richness, but a number of species are largely confined to these communities, at least in North Carolina. Such specialized species include yaupon, Carolina laurel cherry, and devilwood.

Salt spray is a major ecological influence on these communities. Where the vegetation is frequently exposed to salt spray, it is significantly stunted. The forests cannot occur in areas with the most severe salt spray, however, and are dependent on the shelter of dunes for their occurrence. Maritime forests are also subject to the catastrophic disturbances of coastal storms, including high winds, erosion, and salt water flooding from storm tides and overwash.

RARE SPECIES

Maritime forests are relatively low in rare species. Some of the most significant rare plant species include tough bumelia (Sideroxylon tenax), small-flowered buckthorn (Sageretia minutiflora), and four-angled flatsedge (Cyperus tetragonus). Rare animals include the Outer Banks kingsnake (Lampropeltis getula sticticeps) and the eastern coral snake (Micrurus fulvius).

EXAMPLES

Buxton Woods, Dare County
Nags Head Woods, Dare County
Kitty Hawk Woods, Dare County
Theodore Roosevelt State Natural Area, Carteret County
Bald Head Island, Brunswick County

STATEWIDE STATUS

Maritime forests have always been limited in area because of the relatively small acreage of appropriate habitat on the barrier islands and associated mainland. Substantial portions of maritime forest communities have been lost, primarily due to residential and commercial development along the coast. Large forests remain at the sites listed above, while smaller remnant pieces are scattered up and down the barrier islands.

INVENTORY NEEDS

These communities have a fairly low priority for future inventory work. A good inventory of maritime forests was completed in 1988, and most of the remaining areas are known. There is a need for continued monitoring of the high quality sites.

MANAGEMENT ISSUES

Physical Shelter from Salt Spray: Maritime Shrub communities can tolerate substantial salt spray, but Maritime Evergreen Forests and Maritime Deciduous Forests need shelter from extreme salt spray. This is often provided by an expanse of beach and/or tall dunes. Loss of the protective dunes can lead to damage in forests downwind.

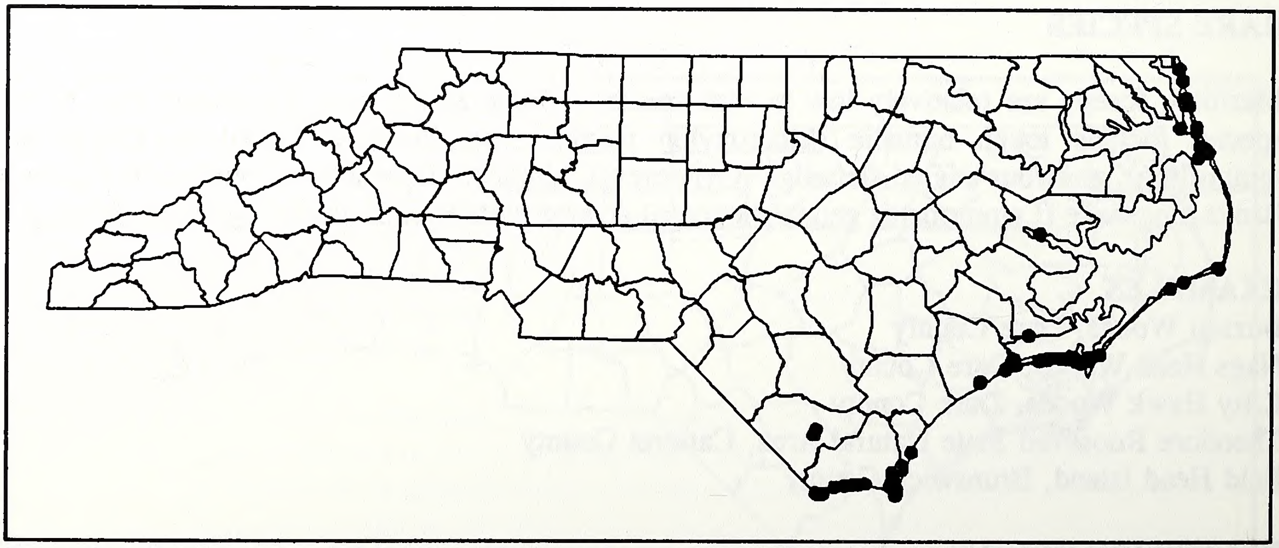
Canopy Integrity: Openings in the canopy can affect the flow of salt spray-laden wind, allowing salt spray to reach the inner branches and understory plants. This may increase salt deposition and can kill the trees. The forest canopy should remain intact and unfragmented.

LONG TERM GOALS

Because so few examples of maritime forest communities remain intact, all of the large examples and most of the high quality small remnants should be protected.

TWO YEAR PLAN

The Natural Heritage Program will provide information to assist with protection efforts underway at several sites. A survey of the insects at Nags Head Woods will be conducted during the next two years.



Recorded Occurrences of Maritime Upland Forests

DRY LONGLEAF PINE COMMUNITIES

COMMUNITY TYPES

Mesic Pine Flatwoods
Pine/Scrub Oak Sandhill
Xeric Sandhill Scrub
Coastal Fringe Sandhill
Piedmont Longleaf Pine Forest

GENERAL DESCRIPTION

Longleaf pine communities are scattered in most of the Coastal Plain and extend into the Piedmont in the south. They were once the most abundant natural communities in the Coastal Plain, occupying most of the land that was not swamp or pocosin. They now occur as scattered remnants.

Dry longleaf pine communities range from moist sites to excessively drained coarse sands which produce near desert conditions for plants. A number of variants are recognized within the community types, determined by variation in moisture, soil, and location. These communities have in common a regime of frequent natural fires which once swept across vast areas of the landscape. The structure and composition of these communities at present strongly depends on the extent to which these fires have continued or have been replaced by prescribed fire.

With frequent fire, longleaf pine strongly dominates the canopy, which may range from sparse to fairly dense but is seldom completely closed. The ground cover is dominated by wiregrass and has a variety of other herbs and low shrubs. In the three sandhill community types, a sparse midstory of scrub oaks is present, with the species varying among the types and variants. In the Mesic Pine Flatwoods community type, oaks are absent and the community has a distinctly two-layered structure of trees and grass. The herb layer is often very diverse. With removal of fire, scrub oaks in the sandhills community types, and shrubs and hardwood trees in the flatwoods community type become dense and exclude the herbs. Piedmont Longleaf Pine Forests are more poorly known. Most existing examples have a mixed canopy of longleaf, loblolly, and shortleaf pine, often mixed with southern red oak and post oak. These communities probably once also had a grassy understory, but it is not known if wiregrass was once dominant. Only one known example has any wiregrass at all.

RARE SPECIES

Dry longleaf pine communities vary in their richness of rare species. The moister Pine/Scrub Oak Sandhills and Mesic Pine Flatwoods may contain a number, including the endangered chaffseed (Schwalbea americana) and Michaux's sumac (Rhus michauxii). The drier sandhills have fewer rare plants, but species such as savanna milkweed (Asclepias pedicillata) and sandhills milkvetch (Astragalus michauxii) do occur. Occurring throughout the moisture range, where the vegetation structure is fairly natural, is the federally Endangered red-cockaded woodpecker (Picoides borealis), as well as the Bachman's sparrow (Aimophila aestivalis) and fox squirrel (Sciurus niger). A number of rare butterflies also occur in these habitats, including the arogos skipper (Atrytone arogos), Meske's skipper (Hesperia meskei), and the dotted skipper (Hesperia attalus).

EXAMPLES

Sandhills Game Land, Richmond County
Fort Bragg, Hoke County
Camp Lejeune, Onslow County
Jones Lake State Park, Bladen County
Singletary Lake State Park, Bladen County
Carolina Beach State Park, New Hanover County
Croatan National Forest, Jones, Pamlico and Carteret counties

STATEWIDE STATUS

From their former dominance over a large portion of the Coastal Plain, dry longleaf pine forests have been reduced to scattered remnants. While a number of examples of each type remain, this represents only a tiny fraction of the original extent. Several variants are extremely rare. Several sites with dry longleaf pine forests are protected, but because of the great diversity of longleaf pine communities and their formerly wide range, this level of protection is far from adequate to represent this theme. A number of rare variants are in particular need of protection. Examples of this theme are particularly scarce north of the Neuse River and in the middle Coastal Plain outside of the Bladen Lakes area.

INVENTORY NEEDS

A statewide inventory of longleaf pine communities was recently completed, and a report on the status of these communities and an analysis of sites will be produced in 1993. While some sites undoubtedly remain to be discovered, this study should describe almost all of the remnant sites. Many of the sites, however, received only limited exploration. More detailed inventory is needed on many known longleaf pine sites, to search for rare species and to better determine their condition and significance. Insect surveys are a high priority, because insect populations may be significantly affected by fire management decisions.

MANAGEMENT ISSUES

Fire: Providing fire on a regular basis appears to be essential to the long term survival of most dry longleaf pine communities. With most wild fires quickly suppressed, fire must be actively provided by prescribed burning. Protected sites which are not burned deteriorate and eventually lose viability. The ideal burn frequency is believed to be every three to five years, with most fires occurring in the growing season. Fire management programs need to be designed with consideration for all plant and animal components of the community.

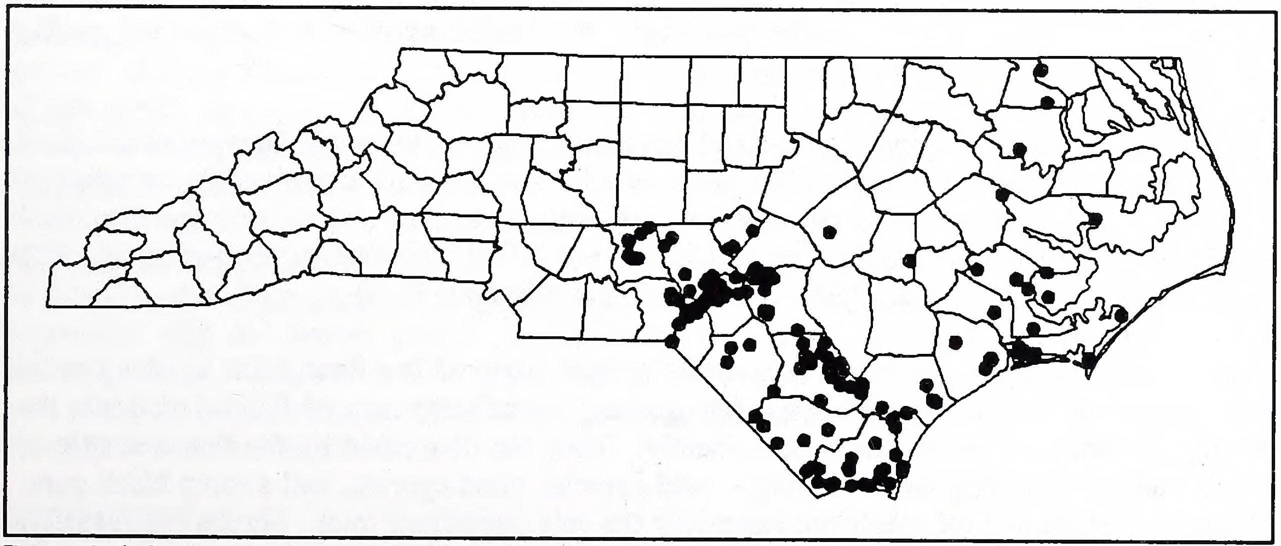
LONG TERM GOALS

Because these communities once dominated large parts of the landscape, protection of some large areas where landscape level relationships and processes are preserved is recommended. This may involve restoration of communities over large areas. Attention must also focus on protection of adequate examples of the full range of community diversity and of rare species populations. Establishment of proper fire management in all protected examples is necessary if they are to remain viable. Because of the complexity of these communities, more basic scientific study is needed on their ecology.

TWO YEAR PLAN

The analysis and report on the longleaf pine community inventory will be completed in 1993. Detailed inventories will be conducted on several high priority sites for which existing information is inadequate. General inventories of Brunswick and Columbus counties will provide information on additional sites.

The Natural Heritage Program will continue to participate in the North Carolina Vegetation Survey's research on longleaf pine communities. The program will contact landowners or managers and explore protection options for several high priority sites. The program will also advise and work with The Nature Conservancy, which has identified longleaf pine communities as a high priority for protection.



Recorded Occurrences of Dry Longleaf Pine Communities

BLACKWATER COASTAL PLAIN FLOODPLAINS

COMMUNITY TYPES

Coastal Plain Levee Forest, Blackwater Subtype
Cypress--Gum Swamp, Blackwater Subtype
Coastal Plain Bottomland Hardwoods, Blackwater Subtype
Coastal Plain Small Stream Swamp, Blackwater Subtype
Sand and Mud Bar (part)
Coastal Plain Semipermanent Impoundment (part)
Oxbow Lake (part)

GENERAL DESCRIPTION

This theme includes the vegetated communities that occur on the floodplains of blackwater rivers. Blackwater rivers originate in the Coastal Plain. In contrast to brownwater rivers, they carry little mineral sediment, in particular little clay and silt. The water chemistry is dominated by dissolved organic matter leached from decomposing vegetation and is generally very acidic and low in nutrients. The water is tea colored but is not cloudy. The soils of blackwater floodplains are usually sandy or mucky and are acidic and infertile. Many floodplains, particularly the larger ones, have at least some development of depositional features such as natural levees, point bars, and ridge-and-swale systems, but these are not as large or prominent as on brownwater rivers. Many smaller blackwater floodplains are filled with muck and are flat and featureless.

Coastal Plain Levee Forest and Bottomland Hardwoods occur in the larger floodplains that have differentiated topographic features. They are usually dominated by low-diversity canopies of laurel oak, water oak, swamp chestnut oak, overcup oak, red maple, loblolly pine, and occasionally Atlantic white cedar. Typical shrubs are Elliott's blueberry, titi, and cane. The Levee Forest also has species typical of levees, especially river birch.

Cypress--Gum Swamps occur in the wettest forested parts of the floodplain, in sloughs, in backswamps, and in the flat, featureless floodplains. These areas may be flooded well into the growing season, sometimes almost permanently. They are dominated by the few tree species able to tolerate such long term flooding -- bald cypress, pond cypress, and swamp black gum. Carolina water ash and red maple are essentially the only understory trees. Shrubs and, usually, herbs are sparse.

Coastal Plain Small Stream Swamps occur in small floodplains that have variable flooding regimes and have topographic features too small to differentiate communities. Their vegetation is a mixture of species from the Levee Forest, Bottomland Hardwoods, and Cypress--Gum Swamp.

Coastal Plain Semipermanent Impoundment communities are primarily beaver ponds, although sediment-blocked tributaries and, occasionally, old millponds develop similar communities. The permanent flooding prevents establishment of trees and kills much of the canopy, but cypress and gum trees may survive for a long time in the pond and provide a partial canopy. Over time, shrubs and herbs of open wetlands such as willow, buttonbush, alder, swamp rose, and sedges become established on the edges, and a diverse community of aquatic plants such as water lilies, cow lilies, water milfoil, and duckweeds develops in the water. The pond site remains distinct for years after a dam is abandoned and the pond drained. A variety of sedges, rushes, or bog species may invade in the years before trees return.

Oxbow Lakes occur along the large rivers in abandoned channel segments that are cut off and blocked so that they retain open water. They are generally lined with cypress or shrubs and may have communities similar to Semipermanent Impoundments, but apparently generally less diverse.

Sand and Mud Bars occur along the river on deposits that are too young or too frequently disturbed to support forest. They are vegetated by characteristic herbs such as panic grass, knotweed, and sedges, or by alder, willow, river birch, or other early successional woody species.

RARE SPECIES

Blackwater river floodplain communities generally do not support many rare species, but a few are characteristic of particular community types or regions of the state. Sarvis holly (Ilex amelanchier) occurs on the edge of the Levee Forest along several blackwater rivers. Plymouth gentian (Sabatia kennedyana), dwarf burhead (Echinodorus parvulus), and Harper's fimbry (Fimbristylis perpusilla) occur on Sand and Mud Bars only along the Waccamaw River. Resinous boneset (Eupatorium resinosum), hottonia (Hottonia inflata), and Carolina grasswort (Lilaeopsis carolinensis) are associated with Semipermanent Impoundments at some sites. A similar variety of animals is associated with these communities. The magnificant ramshorn snail (Planorbella magnifica) is known only from two Semipermanent Impoundment community sites. Mitchell's satyr (Neonympha mitchellii), a butterfly known from only a couple of sites, may be associated with old beaver ponds. Large forested wetlands are important for wide-ranging animals such as black bears and for some forest interior birds. Anhingas (Anhinga anhinga) may nest along the edges of remote ponds. Alligators (Alligator mississippiensis) often use all of the floodplain communities.

EXAMPLES

Lumber River
Waccamaw River
Black River
Merchant's Millpond State Park, Gates County
Croatan National Forest, Jones, Pamlico and Carteret counties

STATEWIDE STATUS

Small blackwater streams are common in the Coastal Plain, although examples with a mature canopy are very rare. A few segments are protected, but no large systems. Large blackwater rivers are less common, though the several that occur have extensive floodplains with intact vegetation. A few old-growth examples exist, of which the most spectacular is the Black River Cypress Forest, but most examples are younger and only in fair condition. Several segments are protected, though again seldom in expanses appropriate to the size of these systems. Sand and Mud Bar communities are common on the larger rivers. Oxbow Lakes are rare, with only a handful in the state. No examples are protected. Semipermanent Impoundments are becoming more abundant as beavers, once extirpated, expand into their former range. The most mature, well-developed examples at present remain those in old millponds, of which a couple are protected.

INVENTORY NEEDS

Blackwater River floodplains, in general, are a low priority for inventory, with moderate priority for some of the rarer community types. An inventory has recently been completed on the Lumber River floodplain, and one was done several years ago along the Waccamaw River. Similar inventory is needed on the Northeast Cape Fear River and on many smaller blackwater rivers and streams.

MANAGEMENT ISSUES

Hydrology and Water Quality: The hydrology and water quality of blackwater rivers both depend on the condition of the watershed. Extensive clearing of land in the watershed increases flood peaks but decreases flood duration, and increases sediment load in the water. In the northern Coastal Plain where soils are fine-textured, widespread farming has caused some blackwater streams to resemble brownwater streams, with apparent corresponding changes in the vegetation.

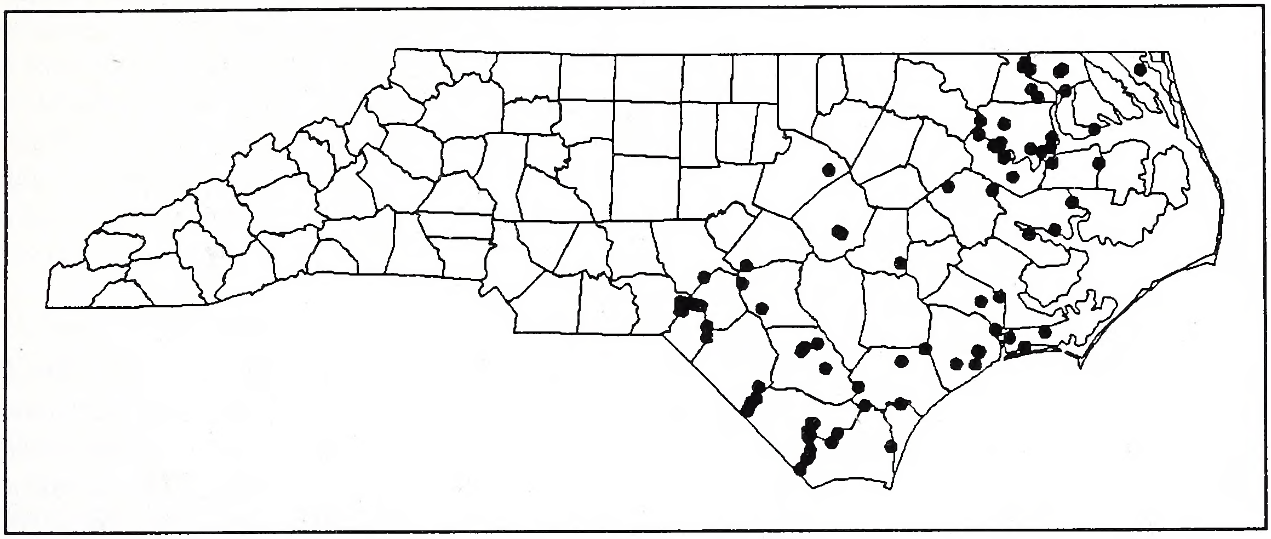
Fragmentation: As in other widespread communities, some component species, particularly animals, may be dependent on large areas and on freedom from edge effects. Floodplain communities, particularly the Levee Forest and Cypress--Gum Swamp, have often remained intact and unfragmented as uplands were cleared, and have provided refuges and migration corridors for animals. Fragmentation of large forested floodplains by roads, clearcuts, and development may have serious effects on animals now regarded as common, as well as on rare species.

LONG TERM GOALS

More protected examples are needed of all community types. For the common community types, protection efforts should focus on the more mature and larger examples, with attempts to protect complete systems where possible.

TWO YEAR PLAN

Natural Heritage Program inventories in Brunswick and Columbus counties will provide new information on high quality blackwater river sites. Additional inventories to be initiated in 1993-1995 on Camp Lejeune may also find high quality examples. The Natural Heritage Program may conduct site-specific inventories where opportunities exist for protection.



Recorded Occurrences of Blackwater Coastal Plain Floodplains

BROWNWATER COASTAL PLAIN FLOODPLAINS

COMMUNITY TYPES

Coastal Plain Levee Forest, Brownwater Subtype
Cypress--Gum Swamp, Brownwater Subtype
Coastal Plain Bottomland Hardwoods, Brownwater Subtype
Coastal Plain Small Stream Swamp, Brownwater Subtype
Sand and Mud Bar (part)
Coastal Plain Semipermanent Impoundment (part)
Oxbow Lake (part)

GENERAL DESCRIPTION

This theme includes the vegetated communities that occur on the floodplains of brownwater rivers. Brownwater rivers originate in the Piedmont or Mountains and flow into the Coastal Plain. In contrast to blackwater rivers, they carry heavy loads of mineral sediment, particularly clay and silt. The water is generally near neutral in pH and high in nutrients. The deposition of sediment in the floodplain provides a periodic nutrient input that keeps the soils rich. Depositional topographic features such as natural levees, point bars, ridge-and-swale systems, and sloughs are well developed, with their size reflecting the size of the river.

Coastal Plain Levee Forest and Bottomland Hardwoods occur in the larger floodplains that have large topographic features. They are usually dominated by high-diversity canopies. The levees adjacent to the river typically have sycamore, river birch, green ash, box elder, American elm, laurel oak, and swamp chestnut oak. Ironwood, red maple, box elder, and paw paw are typical understory trees, and spicebush is a common shrub. Bottomland Hardwoods, which are farther from the river, lack sycamore, river birch, and box elder, and are typically dominated by oaks such as laurel oak, cherrybark oak, swamp chestnut oak, and Shumard's oak. Sweetgum, loblolly pine, and a variety of trees shared with the Levee Forest also occur. Understory species are similar to the Levee Forest. Thickets of giant cane may occur in either community. Vines are often abundant and prominent in these communities.

Cypress--Gum Swamps occur in the wettest forested parts of the floodplain, in sloughs and in backswamps. These areas may be flooded well into the growing season, sometimes almost permanently. They are dominated by the few tree species able to tolerate such long term flooding -- usually bald cypress and water tupelo. Pond cypress, characteristic of blackwater swamps, is absent, and swamp black gum is usually scarce. Carolina water ash and red maple are essentially the only understory trees. Shrubs and herbs are sparse.

Coastal Plain Small Stream Swamps occur in small floodplains that have variable flooding regimes and have topographic features too small to differentiate communities. Their vegetation is a mixture of species from the Levee Forest, Bottomland Hardwoods, and Cypress--Gum Swamp. Brownwater Small Stream Swamps can occur only in the upper Coastal Plain and usually extend only a short distance. They are poorly studied.

Coastal Plain Semipermanent Impoundment communities may occur in either blackwater or brownwater floodplains. They are primarily beaver ponds, but sediment-blocked tributaries and, occasionally, old millponds develop similar communities. The permanent flooding prevents establishment of trees and kills much of the canopy, but cypress and gum trees may survive for a long time in the pond and provide a partial canopy. Over time, shrubs and herbs of open wetlands such as willow, buttonbush, alder, swamp rose, and sedges become established on the edges, and a diverse community of aquatic plants such as water lilies, cow lilies, water milfoil, and duckweeds develops in the water. The pond site remains distinct for years after a dam is abandoned and the pond drained. A variety of sedges, rushes, or bog species may invade in the years before trees return.

Oxbow Lakes occur along the large rivers in abandoned channel segments that are cut off and blocked so that they retain open water. They are generally lined with cypress or shrubs and may have communities similar to Semipermanent Impoundments, but apparently generally less diverse.

Sand and Mud Bars occur along the river on deposits that are too young or too frequently disturbed to support forest. They are vegetated by characteristic herbs such as panic grass, knotweed, and sedges, or by alder, willow, river birch, or other early successional woody species.

RARE SPECIES

Brownwater river floodplain communities support very few rare plant species. A few species which are rare in North Carolina are associated with the rich soils of the Roanoke River floodplain. These include shellbark hickory (Carya laciniosa), sessile trillium (Trillium sessile), Virginia bluebells (Mertensia virginica), stinging nettle (Urtica chamidryoides), cerulean warbler (Dendroica cerulea), and the Mississippi kite (Ictinia mississippiensis). The larger forested floodplains provide remote habitat for animal species needing large areas and forest interiors.

EXAMPLES

Roanoke River
Neuse River
Tar River
Cape Fear River
Swift Creek, Johnson County

STATEWIDE STATUS

The communities of large brownwater rivers, Levee Forest, Cypress--Gum Swamp, and Bottomland Hardwoods, occupy large acreages along the major rivers. Extensive mature examples, however, are much rarer. Substantial amounts remain along the Roanoke River, where several large sites are protected and more protection efforts are under way. Most of the higher Bottomland Hardwoods communities were long ago cleared for farming, and many that escaped were converted to timber plantations. Oxbow Lakes are very uncommon along brownwater rivers, and no examples are protected. Semipermanent Impoundments are fairly common, and there are several protected examples. The Brownwater Subtype of the Coastal Plain Small Stream Swamp type is rare because of its limited range, and no examples are protected. Because the floodplains are narrow, they are subject to the widespread logging of hardwood forests.

INVENTORY NEEDS

Brownwater river floodplains in general are a moderate priority for inventory. The Roanoke River has been extensively studied, but the other major brownwater rivers and smaller brownwater creeks have received little attention. The Albemarle/Pamlico Estuarine Study inventory, which covered the area of several major brownwater rivers, was not able to study most of the floodplain areas in any detail. Rivers farther south, such as the Cape Fear, have received only incidental survey. More information is also needed to refine community classification.

MANAGEMENT ISSUES

Hydrology and Water Quality: The hydrology and water quality of brownwater rivers both depend on the condition of the watershed. Extensive clearing of land in the watershed increases flood peaks but decreases flood duration, and increases sediment load in the water. Most of the major brownwater rivers have been dammed in the Piedmont. Dams reduce sediment load and drastically change the season, duration, and depth of flooding. With opposing influences, it is difficult to tell in which direction some factors have changed from natural conditions. Interbasin transfers of large amounts of water also would affect natural hydrology.

Fragmentation: As in other widespread communities, some component species, particularly animals, may be dependent on large areas and on freedom from edge effects. Floodplain communities, particularly the Levee Forest and Cypress--Gum Swamp, have often remained intact and unfragmented as uplands were cleared. These forests have provided refuges and migration corridors for animals. Fragmentation of large forested floodplains by roads, clearcuts, and development may have serious effects on animals now regarded as common, as well as on rare species.

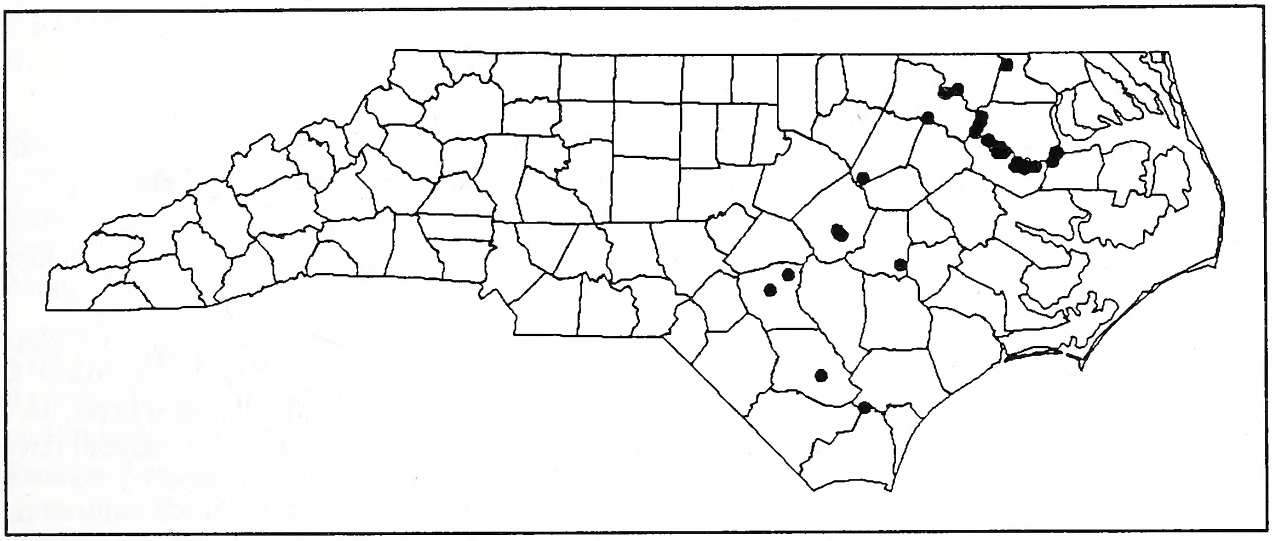
Exotic Species: The rich soils of brownwater river floodplains make them susceptible to invasion by exotic plants. The levees are particularly susceptible, with Japanese honeysuckle, microstegium, and privet especially invasive. These species may also invade Bottomland Hardwoods, particularly if the canopy has been disturbed. The wetter communities are less susceptible to invasion.

LONG TERM GOALS

Public acquisition of lands on the Roanoke River will protect large areas of this theme. Large high quality examples of communities in the other large brownwater river systems and on several smaller brownwater creeks should also be protected. Efforts should be made to protect Oxbow Lakes, of which no examples are currently protected.

TWO YEAR PLAN

The Natural Heritage Program inventory in Brunswick County will cover a portion of the Cape Fear River floodplain in 1993-1995. No other systematic inventories of brownwater rivers are planned, though incidental surveys may be done. The Natural Heritage Program may conduct site-specific inventories if opportunities arise for protection.



Recorded Occurrences of Brownwater Coastal Plain Floodplains

PIEDMONT AND MOUNTAIN FLOODPLAINS

COMMUNITY TYPES

Piedmont/Mountain Levee Forest
Piedmont/Mountain Swamp Forest
Piedmont/Mountain Bottomland Forest
Piedmont/Low Mountain Alluvial Forest
Montane Alluvial Forest
Sand and Mud Bar
Rocky Bar and Shore
Piedmont/Mountain Semipermanent Impoundment
Floodplain Pool

GENERAL DESCRIPTION

Natural communities of Piedmont and Mountain floodplains can be influenced by slight elevation differences created by different sediment deposition patterns. However, relatively steep gradients result in narrow floodplains in the Piedmont and Mountains, so few floodplains contain significant elevation differences. Well developed floodplain landforms are most often lacking.

Where floodplain landforms, such as natural levees, sloughs, and ridges, are poorly developed or are too small to affect communities, the forests contain a mixture of bottomland and mesophytic trees. This community type, the Piedmont/Low Mountain Alluvial Forest, is the most common of the Piedmont's floodplain forest community types, although it seldom covers large expanses.

Much less common are the differentiated levees, sloughs, and ridges found along the larger Piedmont rivers. Levee communities are typically flooded for only brief periods, and may be fairly well drained at times of low water. Sycamore, river birch, and box elder are the most characteristic species. The herb layer is lush and diverse. The bottomlands and sloughs farther from the river are lower and wetter, with a sparse herb layer containing such flood tolerant species as sedges, lizard-tail, and jewelweed.

Several nonforested community types occur in specialized sites on floodplains. Piedmont/Mountain Semipermanent Impoundments occur naturally in beaver ponds. Small, old millponds sometimes provide a similar habitat. These communities have open water in the center and a variety of aquatic and wetland herbs and shrubs along the margins. Floodplain Pools occur in small depressions such as abandoned channels that hold still water for part or all of the year. They usually have few plants, but support aquatic invertebrate communities. They are often important amphibian breeding sites. Sand and Mud Bar and Rocky Bar and Shore communities occur along the stream banks where wetness and flooding disturbance prevent development of a forest canopy. They are dominated by characteristic shrubs and herbs such as alder, willow, panic grasses, and water-willow.

A number of variants can be recognized within the community types in this theme. Variants tend to be determined by the different geologic conditions in different parts of the Piedmont and Mountain regions.

RARE SPECIES

Piedmont and Mountain floodplains are relatively low in rare species. A few specialized plants such as Virginia spiraea (Spiraea virginiana), heart-leaf plantain (Plantago cordata), and harperella (Ptilimnium nodosum) occur in specialized habitats within the floodplains. Some rare amphibians, including the mole salamander (Ambystoma talpoideum) and the four-toed salamander (Hemidactylium scutatum) breed in Floodplain Pools.

EXAMPLES

Brown's Creek, a portion of which is contained within the Pee Dee National Wildlife Refuge, Anson County
New Hope Creek, upper end of Jordan Lake, Durham County
Mason Farm Biological Reserve, Orange County
Along the Dan River, Stokes and Rockingham counties
Eno River State Park, Orange and Durham counties
Along the French Broad River, Madison County

STATEWIDE STATUS

As with almost all Piedmont community types, widespread human influence has heavily altered or eliminated a large proportion of the state's Piedmont and Mountain floodplain communities. Because frequent flooding limits the potential human uses of floodplains, more of these than of some other Piedmont communities still exist in nearly natural condition. Nevertheless, Piedmont and Mountain floodplains continue to be altered, and very few of the rarer community types and variants remain. A number of protected areas represent this theme but most are relatively small and fragmented.

Widespread alterations of floodplain systems have occurred due to agriculture and logging operations, although the degree of alteration varies. Other disturbances include urban development, road and utility corridors, and recreational use. Perhaps the most extreme alteration has been the construction of large reservoirs, which have permanently flooded vast floodplain areas. Less direct alterations include changes in flooding regime caused by upstream impoundments and by urbanization in the watershed.

INVENTORY NEEDS

Floodplain communities are a moderate priority for inventory. Very few examples are known in the mountains. While many examples are known in the Piedmont, studies that would give a comprehensive picture of sites along a particular river, or allow comparison of one river to another, are lacking.

MANAGEMENT ISSUES

Hydrology: Floodplain community types are adapted to intermittent flooding of varying frequency and duration. Permanent impoundment or permanent prevention of flooding will alter the communities in the long term.

Invasion by exotic species: Japanese honeysuckle, microstegium, privet, and a variety of other non-native species have come to dominate the lower strata of many floodplain communities. Canopy opening by past logging may be responsible, but the reason why some areas are invaded and others are not is unclear.

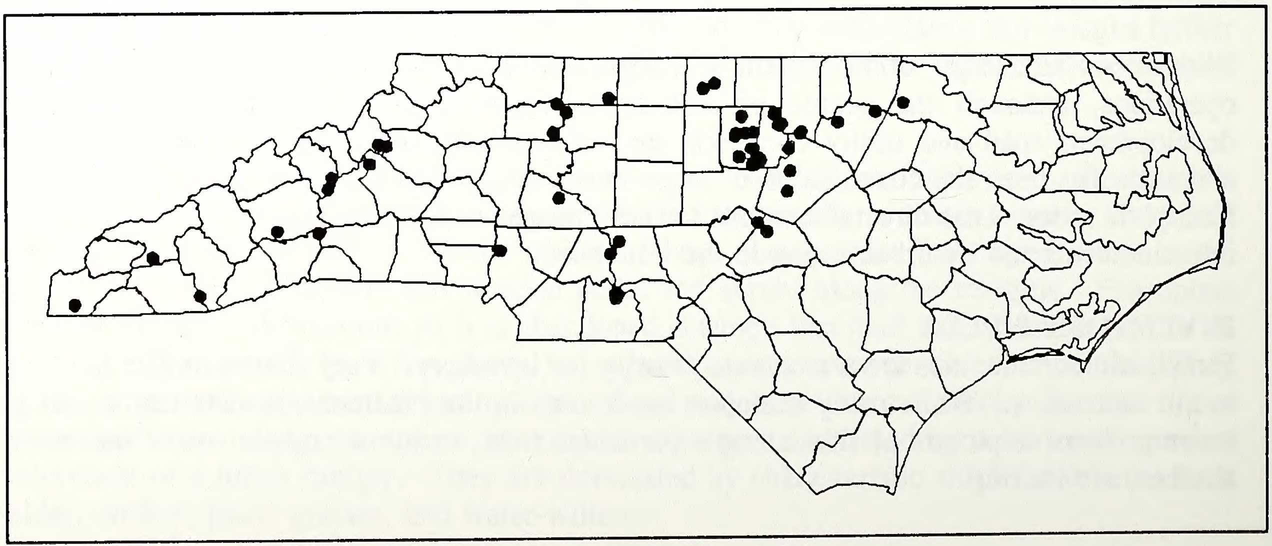
Beavers: As beavers spread back into their former range, they can be expected to inhabit floodplain areas, building impoundments and creating long-lived open communities. The former abundance and ecological effect of beavers are not well known, but these animals undoubtedly played a significant role in the floodplain landscape, and may do so again.

LONG TERM GOALS

While most of the community type variants in this theme are common, several such as the Montane Alluvial Forest are rare enough that all good examples remaining should be protected. Protection efforts for other types should focus on the larger and more mature examples, on examples supporting rare species, and on continuous stretches of floodplain.

TWO YEAR PLAN

During 1993-1995, several county inventories supervised by the Natural Heritage Program will examine potential high quality floodplain areas. Inventories of one or more mountain national forest ranger districts also have some potential for identifying floodplain communities.



Recorded Occurrences of Piedmont and Mountain Floodplains

RIVERINE AQUATIC COMMUNITIES

COMMUNITY TYPES

freshwater tidal river communities
Coastal Plain river communities
Coastal Plain stream communities
Piedmont river communities
Piedmont stream communities
Mountain river communities
Mountain stream communities

GENERAL DESCRIPTION

There are nine major river basins in North Carolina, as well as two coastal drainage basins. Riverine Aquatic Communities include all perennial, flowing water ecosystems in these basins - all rivers, creeks, and streams. These communities are found everywhere in the state and are of major ecological importance since the majority of animal species, including human beings, depend on them for their water supplies. Riverine communities are highly diverse, ranging from mountain torrents to placid and meandering coastal plain rivers. The community types, however, are still in need of community classification parallel to that of terrestrial communities.

Riverine communities overlap only slightly with those of lakes and other still waters. Flowing waters are well-mixed, with only slight gradients in terms of oxygen, nutrients and temperature. They do not experience the temperature and oxygen stratification which often occur in still waters. Consequently, species inhabiting riverine systems are typically less tolerant of prolonged temperature and oxygen stress, although they need to be resistant to the turmoil of flooding.

Another difference is that flowing water systems are less dependent on plants as the basis for the food chain, although several species of macrophytes may be important constituents. Generally, detritus entering the system from adjacent lands is more important as a source of energy and materials. Animals, rather than plants, tend to be the most conspicuous members of the community.

Ecological differences exist between small streams and large rivers, and between regions containing different substrates. For example, bottom type and water chemistry will vary between Piedmont and Coastal Plain rivers, and between blackwater and brownwater streams. Another fundamental difference between types of riverine systems in North Carolina results from the biogeographic separation between the Mississippi River drainage system and the Atlantic Slope. The Mississippi ecosystem is one of the oldest and greatest freshwater biomes on earth; it is highly diverse in fish, mollusks, crustaceans, insects and other species of aquatic animals. Only a few of North Carolina's mountain rivers drain toward the Mississippi River.

The great majority of North Carolina drains toward the Atlantic Ocean. Atlantic Slope rivers are each relatively isolated from one another, emptying separately into the ocean. Many aquatic species have no means of moving between river basins except in the rare event when geological forces result in a change in drainage patterns. Because of this, aquatic communities tend to be lower in diversity in the Atlantic Slope streams compared to those of the Mississippi drainage, but also contain a number of species endemic to just one or two rivers.

RARE SPECIES

The greatest proportion of animals on federal and state lists of Endangered and Threatened species inhabit riverine aquatic communities. A few are naturally rare endemics, such as the Cape Fear shiner (Notropis mekistocholas) and the Neuse River waterdog (Necturus lewisi). However, many aquatic species which were formerly quite common have become rare, such as the yellow lampmussel (Lampsilis cariosa) and many other freshwater mussel species. These declines are primarily due to water quality degradation, which has also added to the rarity of the endemic species.

EXAMPLES

Atlantic Slope Drainage
- Dan River
- Eno River
- Tar River
- Neuse River
- Black River
- Lumber River
- Naked Creek
- Goose Creek
- Swift Creek

Mississippi River Drainage
- New River
- French Broad River
- Little Tennessee River

STATEWIDE STATUS

The loss of aquatic communities is often not as apparent as the loss of terrestrial communities. The rivers are still there, but observant fishermen may notice significant changes in the numbers and kinds of organisms inhabiting these communities. Freshwater mussels were formerly so abundant that they provided a major wildlife food source, and their natural filtering mechanism helped to cleanse the waters. Recent field studies have documented precipitous declines in the populations of many of North Carolina's mussel species. The major problem is poor water quality. Many aquatic species are sensitive to the sediments, nutrients, and other pollutants which enter the waterways.

Impoundments also result in a loss of riverine communities, by changing the flowing aquatic habitat to a still water system. Species adapted to the temperature and oxygen conditions of flowing water are unable to survive in an impoundment. Impoundments also alter flow patterns, temperature, and oxygen conditions downstream of the dam, as well as create barriers to the movement of species up and down the watercourse.

Generally, North Carolina's smaller rivers tend to retain more high quality habitat because they have been less affected by impoundments and heavy pollutant loads than the larger rivers. Unfortunately, these same small rivers are becoming increasingly desirable for impoundment as public water supplies, precisely because of their good water quality. A few of North Carolina's streams, mostly in the mountains, are permanently protected by public ownership of all or most of their watersheds.

INVENTORY NEEDS

Certain groups of aquatic animals have been fairly well studied or are the subjects of ongoing inventory efforts by several state agencies. Fish and aquatic salamanders have been fairly well documented, and freshwater mussels are also the current subject of intensive survey efforts. Aquatic insect surveys have also been conducted throughout the state.

Crustaceans and aquatic snails are less well understood, as are certain groups of insects, such as dragonflies. All three of these groups are known to have a number of rare species represented in North Carolina. Several species of aquatic macrophytes are also in need of further inventory.

MANAGEMENT ISSUES

Water Quality: Protection of riverine communities is very difficult because they are so greatly affected by activities throughout the watershed. Some sources of pollution can be greatly reduced by careful control of sedimentation and stormwater runoff. Leaving a buffer zone of vegetated, undisturbed soil along the river banks is also very helpful. Adequate treatment of wastewaters to reduce nutrients and dechlorination of the treated wastewater are important protections for aquatic systems.

Hydrology: Impoundments may be necessary for public water supplies, but they can often be designed to reduce adverse effects on downstream aquatic communities. Carefully designed water releases can provide appropriate temperature, oxygen, and flow conditions for aquatic organisms.

Exotic Species: As in many terrestrial communities, aquatic communities have been affected by the introduction of species not native to the site. The Asian clam and the zebra mussel are examples of exotic species which can have disastrous effects on the native aquatic species. Even transport of aquatic species from one water basin to another where they are not normally found can have detrimental consequences.

LONG TERM GOALS

Protection of streams which still have high quality natural communities is very important. The number of protected watersheds should be increased to include the best remaining habitats and representative examples of the statewide diversity of aquatic communities. Further work on classification of river and stream aquatic communities also needs to be done.

TWO YEAR PLAN

Inventory work on riverine dragonflies is a fairly high priority, and may be initiated within the next two years. The Natural Heritage Program will continue to support the protection efforts of other organizations.

MOUNTAIN BOGS AND FENS

COMMUNITY TYPES

Swamp Forest--Bog Complex, Typic Subtype
Swamp Forest--Bog Complex, Spruce Subtype
Southern Appalachian Bog, Northern Subtype
Southern Appalachian Bog, Southern Subtype
Southern Appalachian Fen

GENERAL DESCRIPTION

Montane bogs are among the rarest natural communities in the Southern Appalachians and in North Carolina. Unlike northern bogs of glacial origin, Southern Appalachian bogs form in poorly drained depressions or on gentle slopes, generally in relatively flat valley bottoms which are not subject to flooding. They may vary from being permanently wet to intermittently dry and are generally fed by seepage. They are underlain by wet organic or mucky mineral soils, which are very acidic.

The Southern Appalachian Bog and Southern Appalachian Fen community types have a mosaic or zoned pattern of shrub thickets and herb dominated areas, mostly underlain by sphagnum mats. Trees such as red maple, white pine, hemlock, pitch pine, and in the northern bog subtype, red spruce, may be scattered throughout or may dominate on the edges. The shrub and herb layers of the bog, while not highly diverse, are uniquely adapted to the acidic, nutrient-poor environment of the bog and may include numerous rare species. Swamp Forest--Bog Complex types occur along streams and are more dominated by trees, but have boggy herbs and sphagnum in openings.

The factors responsible for creating and maintaining bog communities are not well known. Grazing has been nearly universal in bogs, and few examples exist in pristine condition. Most examples are experiencing invasion of shrubs or trees at the expense of the herbaceous zones. This tendency toward rapid succession suggests that some form of periodic or chronic natural disturbance, now disrupted, may have kept the bogs open. Potential past disturbances include flooding by beavers, grazing by herds of large mammals, fire, and clearing by Native Americans.

RARE SPECIES

Bog communities are known for their concentrations of rare species. Many are disjunct from northern bogs and fens, such as Canada yew (Taxus canadensis), long-stalked holly (Ilex collina), northern white beakrush (Rhynchospora alba), Canada burnet (Sanguisorba canadensis), and bog fern (Thelypteris simulata). Others are southern Appalachian endemics, such as Gray's lily (Lilium grayi), mountain sweet pitcher plant (Sarracenia jonesii), Cuthbert's turtlehead (Chelone cuthbertii), and bunched arrowhead (Sagittaria fasciculata).

EXAMPLES

Long Hope Valley, Ashe and Watauga counties
Sparta Bog, Alleghany County
Boone Fork Bog, Hoot Camp Branch Bog, Sims Creek Bog; Blue Ridge Parkway, Watauga County
Panthertown Valley, Nantahala National Forest, Macon County
Etowah Bog, Henderson County
Alarka Laurel, Swain County
Pineola Bog, Avery County
Bluff Mountain Preserve, Ashe County

STATEWIDE STATUS

Because of the scarcity of flat, wet sites in the mountains, all community types and subtypes of bogs are inherently rare. Their occurrence in accessible, low elevation sites which have long been subject to human activity have made them extremely rare today, and their future viability is in considerable doubt. Mountain bogs are increasingly threatened by draining and filling for agriculture or development, by sediment loading due to removal of forested buffer areas surrounding the wetland, by nutrient and chemical runoff which alters the acidity and quality of the water, and by other direct and indirect disturbances. A handful of examples are currently protected. Those bogs that remain in relatively good condition are often small, discreet, and dispersed, presenting remarkable opportunities for biogeographical studies and insights into past and present vegetation changes.

INVENTORY NEEDS

A fairly comprehensive inventory of mountain bogs is nearing completion. This study has identified additional examples of high quality bogs in the state and has added information about rare species in previously known bogs. While the priority for additional reconnaissance inventory is therefore low, many of the sites identified are in need of follow up inventory to more fully assess significance and protection options. Very little work has been done on invertebrates in these communities, and many rare species may occur in these unusual habitats.

MANAGEMENT ISSUES

Hydrology: Bog communities are highly dependent on the hydrological conditions of the site. Drainage, impoundment, or groundwater pumping can significantly alter site hydrology. Hydrology may be affected indirectly by entrenchment of streams resulting from clearing in the watershed. Bogs can also be affected by changes in the quantity or quality of inflow. Therefore, it is important to protect the water source, as well as the bog itself.

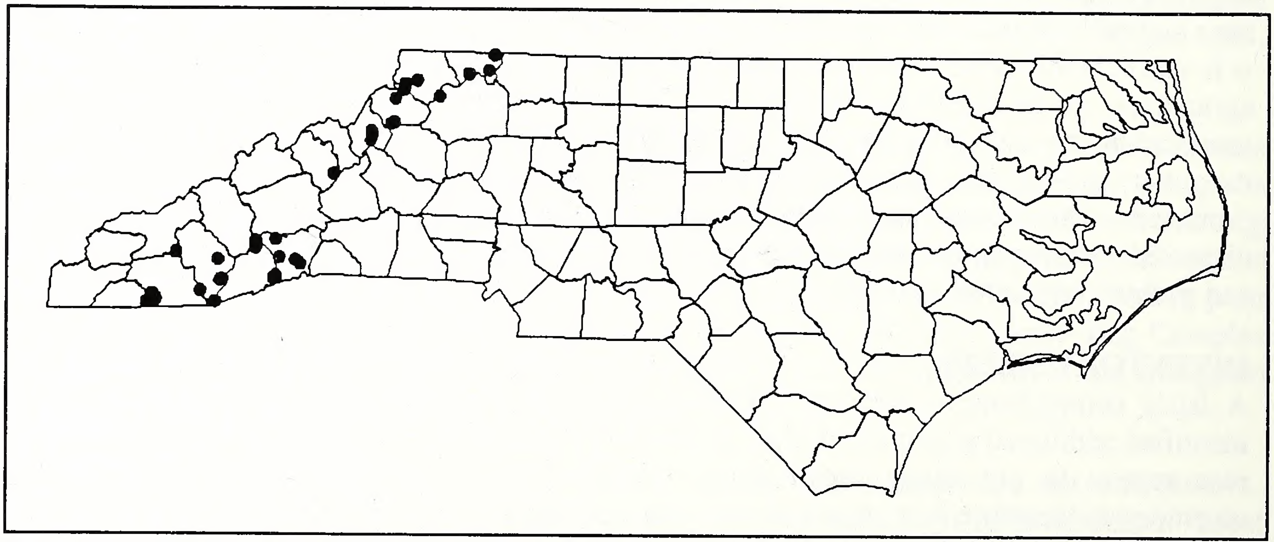
Succession: Many bogs seem to be experiencing relatively rapid succession toward shrubs and trees, but the reasons for this are not well known. While this may represent natural primary succession which will eventually lead to a forest community, it is not clear why this process seems to be proceeding so rapidly in recent decades after much longer periods of relative stability. Hand clearing has been used in places to stem the process in the short term. Research on the natural dynamics of bogs is urgently needed.

LONG TERM GOALS

Because of their rarity, small size, and diversity, all good quality examples of mountain bogs should ideally be protected.

TWO YEAR PLAN

A comprehensive report on the status and significance of mountain bog sites will be prepared using the results of the recent inventory. A project is being initiated to contact owners of many mountain bogs to encourage protection. The Natural Heritage Program will also encourage protection of high priority sites by other agencies and organizations.



Recorded Occurrences of Mountain Bogs and Fens

UPLAND SEEPAGES AND SPRAY CLIFFS

COMMUNITY TYPES

High Elevation Seep
Low Elevation Seep
Hillside Seepage Bog
Spray Cliff

GENERAL DESCRIPTION

The communities in this theme are wetlands that occur on sloping uplands in the Piedmont and Mountain regions. The soils are generally saturated permanently or for long periods. They are generally fairly small and contrast sharply with adjacent communities, though boundaries may be gradational.

Spray Cliffs are areas kept wet by spray from waterfalls. Most of their area is generally vertical cliffs, but gentle slopes, talus, and soil at the base of cliffs is also included. As in the rock outcrop communities, vegetation is very patchy, reflecting the patchiness of soil accumulations. The microclimate is generally moderated by the flowing water and sheltered position of the cliffs. Though water flow may vary with rainfall, these are probably among the most stable environments in North Carolina. Trees such as Canada hemlock, yellow birch, or buckeye, rooted in crevices and between rocks, often grow to large size and may shade the entire area. Rhododendron may be dense in patches of soil. The bare wet rocks generally have a great diversity of mosses and liverworts. Herbs in small soil pockets include saxifrage, alumroot, bluets, galax, and a wide variety of ferns and sedges.

The other three community types are fed by seepage. Their soils are saturated for much or all of the year, but they are seldom if ever flooded. The rarest type is the Hillside Seepage Bog. These communities, in a few Piedmont locations, are wet enough to have boggy vegetation which includes peat moss, pitcher plants, a variety of sedges, cinnamon fern, and bog orchids. The vegetation is generally a patchy mix of shrubs and herbs with an open tree canopy. Alder, highbush blueberry, viburnums, red maple, sweetgum, and black gum are typical woody dominants. Many species characteristic of the Coastal Plain occur in these communities, including laurel-leaf greenbriar, pitcher plants, and in some, pond pine. Fire may have played a role in keeping Hillside Seepage Bogs open enough to allow persistence of light-requiring bog species. At least two distinct variants are recognized.

Low Elevation Seeps, occurring in uplands or edges of floodplain throughout much of the state, are also very wet but differ in vegetation; the factors which cause these differences are poorly known. Characteristic species include lizardtail, jewelweed, cinnamon fern, royal fern, rushes, and false nettle. Trees such as red maple may be present, or the seep may be shaded by canopy species from adjacent forests. Numerous variants could probably be recognized but are not yet defined.

High Elevation Seeps occur in the higher mountains, where they are surrounded by spruce-fir forests, Northern hardwood forests, or grass and heath bald communities. Characteristic species include turtlehead, saxifrage, various sedges, jewelweed, meadow-rue, poison hemlock, umbrella leaf, bee balm, and waterleaf. High Elevation Seeps are quite variable in vegetation and setting. Some are open and somewhat boggy, with peat moss, sundews, and even cranberries present. Others are shaded by canopy and more closely resemble a rich Northern hardwood forest.

RARE SPECIES

High Elevation Seeps are often rich in rare plants. Some species, such as Canada burnet (Sanguisorba canadensis), bog goldenrod (Solidago uliginosa), cranberry (Vaccinium macrocarpon), and grass-of-Parnassus (Parnassia grandifolia), are shared with bogs; others, such as Gray's lily (Lillium grayii), are shared with grassy balds; and others, such as trailing wolfsbane (Aconitum reclinatum) and bent avens (Geum geniculatum), are shared with cove forests and stream banks. Spray Cliffs are also rich in rare plant species, particularly mosses, liverworts, and ferns. Rare animals in these communities are not well known, but high potential exists for very rare and for disjunct invertebrates. Hillside Seepage Bogs and Low Elevation Seeps support few rare plants, but a couple of very rare species, littleleaf sneezeweed (Helenium brevifolium) and small-anthered bittercress (Cardamine micranthera), are associated with them. Thorey's grayback dragonfly (Tachopteryx thoreyi), and possibly other rare invertebrates, are also associated with them.

EXAMPLES

Grandfather Mountain, Avery and Watauga counties
Roan Mountain Massif, Pisgah National Forest, Avery and Mitchell counties
Fork Ridge/Mount Hardy, Blue Ridge Parkway and Pisgah National Forest
Black Ankle Bog, Montgomery County
Sand Branch Hillside Seepage Bog, Montgomery County
Link (Sloan) Bog, Iredell County
Windy Falls, Nantahala National Forest
Whitewater Falls, Nantahala National Forest
Dry Falls, Nantahala National Forest
South Mountains State Park, Burke County
Hanging Rock State Park, Stokes County

STATEWIDE STATUS

All of these communities represent very small total acreages. Hillside Seepage Bogs are extremely rare, with only a handful known in two clusters. A number of examples have been severely degraded by logging, grazing, and unnatural succession. Two examples of one variant are protected. High Elevation Seeps and Spray Cliffs are fairly rare. Most examples have escaped direct disturbance, though many may have been affected by logging or development on surrounding lands. A number of examples of each are under protective designation, but not all the variation is protected. Low Elevation Seeps potentially occur throughout the state. Their status is poorly known but they are not believed to be rare. Many examples may have been degraded by logging or grazing. No examples are known to be protected.

INVENTORY NEEDS

Upland Seepages and Spray Cliffs are a moderate to high priority for inventory. Hillside Seepage Bogs are extremely rare, but because they are very difficult to find, most examples are found accidentally or by reports from others. Spray Cliffs and High Elevation Seeps have attracted attention in the more frequently studied mountain areas, but many ranges have had little study. Even the more heavily visited ranges have remote, unexplored areas. Low Elevation Seeps are poorly known and more information is needed.

MANAGEMENT ISSUES

Hydrology: The seepage communities are dependent on ground water. Pumping wells, clearing watersheds, and diverting water flow can have a drastic effect on them. Spray Cliffs may be affected by changes in stream flow and water quality resulting from activities in the watershed.

Fire: At least some Hillside Seepage Bogs occur amid natural communities that burned frequently. Fire may be an important factor in maintaining the structure of the vegetation and in keeping the canopy open enough to support bog species. Fires probably did not always penetrate the bogs when the surrounding area burned. More study and experimentation is needed on the effects of fire frequency and intensity on these communities. Low Elevation Seeps appear not to be flammable, and fires in surrounding communities probably did not penetrate them. High Elevation Seeps and Spray Cliffs probably did not naturally burn.

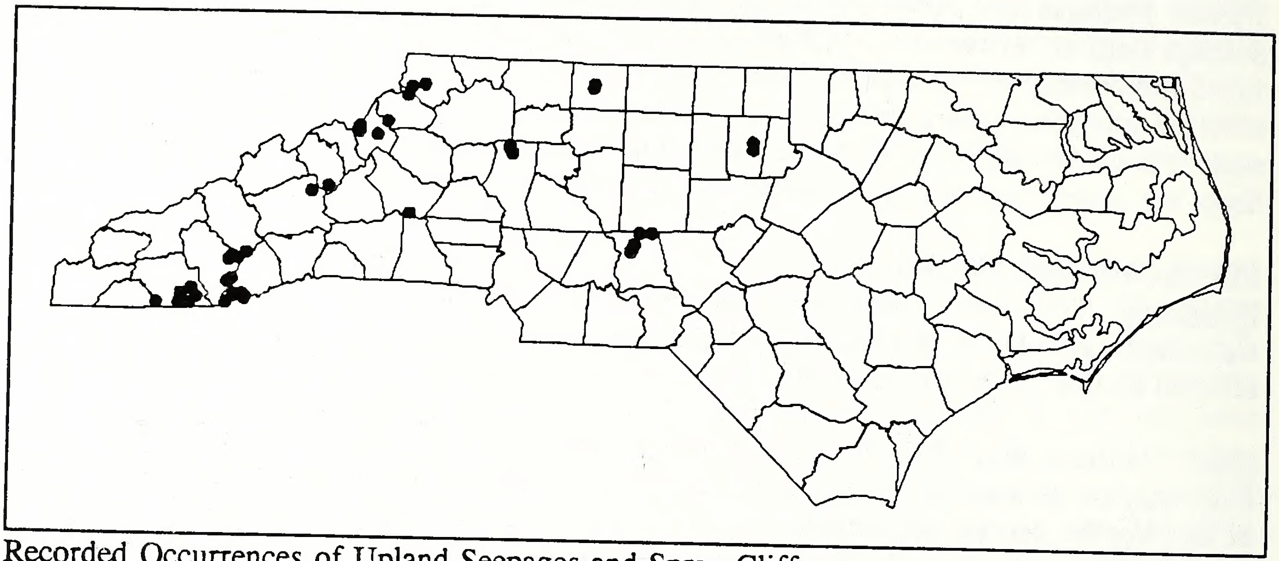
Public Use: The soft, wet soils of the seepage communities are very sensitive to trampling. Even moderate foot traffic can cause extensive disturbance. The shallow, slippery soils of Spray Cliffs are also very sensitive to trampling. Visitors also often remove plants from vertical rocks within reach, either from curiosity or carelessness.

LONG TERM GOALS

Hillside Seepage Bogs are rare enough that all viable examples ideally should be protected. Some experimentation with different sites will be necessary to determine the best management. High Elevation Seeps and Spray Cliffs are highly variable, and additional examples are needed to protect this variation. Low Elevation Seeps are believed to be common, but protection of a number of good quality examples, well distributed across the range, is needed. In all cases, protection efforts should include adequate buffers and protection of the community's hydrology.

TWO YEAR PLAN

In 1993-1995, the Natural Heritage Program will conduct an inventory in one or more ranger districts in the mountain national forests. These inventories will cover poorly explored areas with potential for seepage and spray cliff communities. Several county inventories in the Piedmont and Coastal Plain also will examine areas with potential for these communities. Landowner contact and assistance with other protection efforts may be undertaken on several high priority sites.



Recorded Occurrences of Upland Seepages and Spray Cliffs

PIEDMONT UPLAND POOLS AND DEPRESSIONS

COMMUNITY TYPES

Upland Pool
Upland Depression Swamp Forest

GENERAL DESCRIPTION

These communities occur in shallow depressions which hold water in wetter parts of the year. They generally dry up by the end of summer, but are flooded long enough into the growing season to contain wetland vegetation that contrasts with the surrounding uplands. Most occur in the Piedmont, where they are associated with mafic rocks or shales, but a couple of Upland Pools are known from the Mountain region, where they occur on quartzite.

Upland Depression Swamp Forests occur in shallower depressions than Upland Pools, and are flooded for shorter periods. They have a closed canopy of wetland trees, usually willow oak but sometimes overcup oak and occasionally other species. Understory and shrubs are usually sparse, but highbush blueberries or deciduous holly may be scattered. The ground cover is usually sparse, but spring ephemerals such as spring beauties may be abundant in areas which dry fairly soon in the spring. Sedges, rushes, manna grass, and pine tree moss are the most typical herbs.

Upland Pools occur in wetter sites, where the water is deep enough or long-standing enough to prevent development of a closed tree canopy. The vegetation varies widely, and it is likely that this type could be split into several community types. Trees of the Upland Depression Swamp Forest community type may occur around the edges, and red maple, sweetgum, or black gum may occur as scattered individuals. Wetland shrubs such as buttonbush, dog hobble, and titi occur. Herbs include sedges, rushes, cinnamon fern, and sometimes peat moss.

Both of these community types often have abundant amphibians. Because the pools do not support fish, which eat amphibian eggs and larvae, they are excellent amphibian breeding sites.

RARE SPECIES

Piedmont upland pools and depressions very seldom support rare plant species. A couple of rare amphibians, the four-toed salamander (Hemidactylium scutatum) and the mole salamander (Ambystoma talpoideum), sometimes breed in them. There is some possibility for the discovery of rare invertebrates. Several rare crustaceans are known only from these habitats.

EXAMPLES

Roberdo Bog, Uwharrie National Forest, Montgomery County
Pleasant Grove Hardpan Bog, Uwharrie National Forest, Montgomery County
Donnelley Bog, Chatham County
Shortoff Mountain Pond and Linville Gorge Pond, Pisgah National Forest
Frogsboro Upland Depression Forest, Caswell Game Land, Caswell County
Badin Upland Depression Swamps, Uwharrie National Forest, Montgomery County
Meadow Flats, Duke Forest, Orange County

STATEWIDE STATUS

Both of these community types are rare throughout their range. Upland Pools are extremely rare, with only five examples known. All five are protected. Some potential exists for finding a few others. Upland Depression Swamp Forests are known from approximately 20 sites. Only two small examples are protected.

INVENTORY NEEDS

Because of their rarity and the small number of protected examples, these communities are a high priority for inventory. Invertebrate and salamander inventories are needed.

MANAGEMENT ISSUES

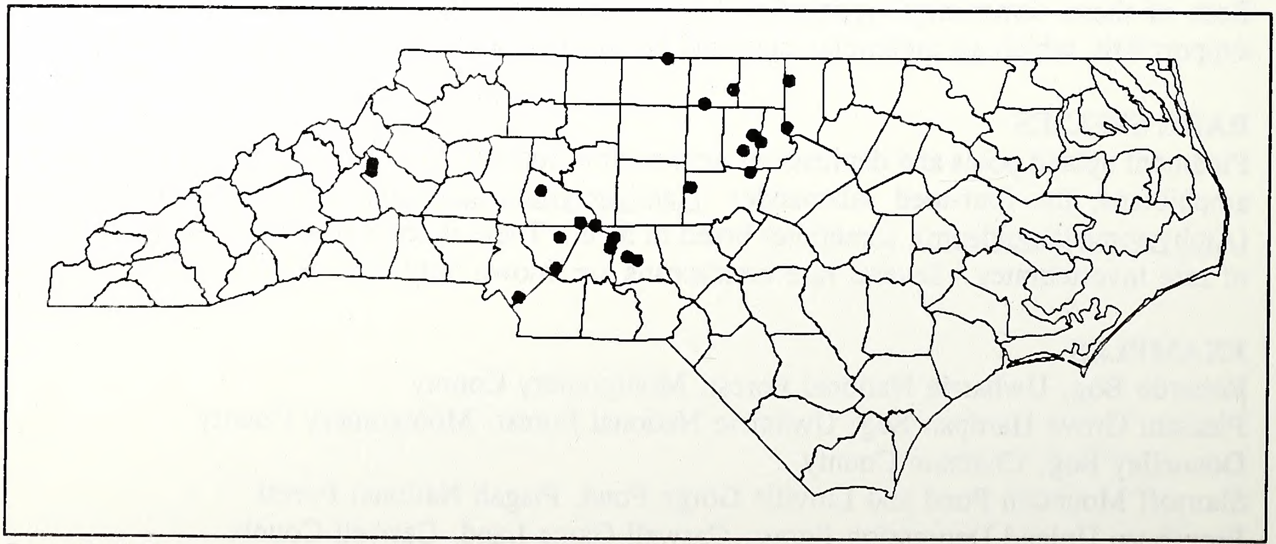
Surrounding Uplands: The depressions that contain these communities are partly filled by runoff as well as by rainwater. Although the watersheds are usually small, disturbance within the watershed may increase sediment loads or nutrient levels in the water and degrade the aquatic communities. Adjacent upland habitat is also needed for the adults of the amphibians that breed in the depressions.

LONG TERM GOALS

Upland Pools are rare enough that all viable examples should be protected. Upland Depression Swamp Forests are rare enough that all higher quality examples and examples in different geographic regions should be protected.

TWO YEAR PLAN

The inventory of communities associated with Piedmont mafic rocks, already in progress, focuses on these community types. This inventory will be completed in 1993-1995. The Natural Heritage Program will initiate landowner contact for several high priority sites when the inventory is completed.



Recorded Occurrences of Piedmont Upland Pools and Depressions

COASTAL PLAIN NONALLUVIAL MINERAL WETLANDS

COMMUNITY TYPES

Wet Marl Forest
Nonriverine Wet Hardwood Forest
Nonriverine Swamp Forest

GENERAL DESCRIPTION

Nonalluvial mineral wetlands occur on flat, poorly drained areas of the outer Coastal Plain and occasionally in shallow depressions such as Carolina bays. The soils in these sites are saturated in the wetter seasons and may have shallow standing water. Unlike river floodplain wetlands, these communities do not experience overflow flooding. Their wetness comes from poor drainage and slow surface flow from adjoining peatlands. The soils are less acidic and infertile than the peat soils of pocosins, but they do not have the regular nutrient input of river floodplains. Organic deposits are generally lacking, though occasional examples are found on organic soils where some other factor offsets the tendency of these soils to support pocosins.

The three community types differ in wetness and in the nature of the soil. Nonriverine Swamp Forests occur in the wettest sites, saturated for much of the growing season. They are dominated by trees tolerant of extreme wetness, such as bald cypress, swamp black gum, and red maple. A distinctive variant, transitional to peatland communities, has these species mixed with loblolly pine, pond pine, and Atlantic white cedar. Some Nonriverine Swamp Forests have a dense closed canopy with little vegetation beneath, while others, perhaps due to past logging, have an open canopy and dense shrubs.

Nonriverine Wet Hardwood Forests occur in less wet areas. They are dominated by trees typically called "bottomland hardwoods" -- cherrybark oak, laurel oak, swamp chestnut oak, tulip poplar, sweetgum, American elm, and red maple. Some loblolly pine is occasionally present. The undergrowth is usually open beneath the closed canopy, but sometimes dense cane or shrubs occur.

The Wet Marl Forest type occurs where marl or limestone occurs near the surface and affects the soil. Although they are wet, these soils are not acidic and are more fertile than most Coastal Plain soils. The vegetation is dominated by a diverse mixture of trees, including nutmeg hickory, Shumard's oak, Carolina basswood, swamp chestnut oak, water hickory, bitternut hickory, and sweetgum. The understory, shrub, and herb layers are similarly diverse. Understory trees include rich-site species such as pawpaw and redbud as well as more widespread species. Dwarf palmetto is an abundant and distinctive part of the shrub layer.

RARE SPECIES

Nonalluvial mineral wetlands in general support very few rare species. The larger tracts provide habitat for black bear, and the southern twayblade orchid (Listera australis) occurs in some. Wet Marl Forests support several rare species, including the only locations in the state for nutmeg hickory (Carya myristiciformis). The eastern woodrat (Neotoma floridana) occurs in areas with abundant dwarf palmetto.

EXAMPLES

Alligator River National Wildlife Refuge, Dare and Hyde counties
Great Dismal Swamp National Wildlife Refuge, Camden, Gates and Pasquotank counties
Hoffman Forest Cypress Natural Area, Jones and Onslow counties
East Dismal Swamp, Washington County
Bethel/Grindle Hardwood Flats, Pitt County
Gum Swamp Hardwood Forest, Croatan National Forest
Rocky Point Marl Forest, Pender County

STATEWIDE STATUS

North Carolina is believed to have the majority of all of these community types. Nonalluvial mineral wetlands are more vulnerable to destruction and degradation than most other wetlands because they are more easily drained and because cutting apparently alters their composition more than it does many communities.

Wet Marl Forest is one of the rarest community types in the Coastal Plain. It is currently known to exist in only two sites near the town of Rocky Point. Nonriverine Wet Hardwood Forests were once abundant in the northeastern part of the state, but most were drained and cleared for agriculture long ago. Intensive pine culture has eliminated many examples in more recent times. A handful of fairly large, mature examples remain, but all are extremely threatened. Cutting of mature hardwood forests is occurring very rapidly, and most are regenerated in pines rather than the hardwoods that previously dominated. It is unlikely that any sizeable mature examples will remain within a few years without protection. Only a few small examples are currently protected. Nonriverine Swamp Forests, being wetter, have been less systematically destroyed. Most examples have been heavily logged, however. Cypress often did not regenerate after logging, leaving a degraded canopy of red maple and black gum. At present large areas of the mixed canopy variant are contained in Alligator River National Wildlife Refuge and other public lands. Large areas of cutover maple-gum swamp are also publicly owned. Several small examples of cypress-dominated Nonriverine Swamp Forests, reported to be virgin, are protected. More protection is needed, particularly for high quality examples with cypress or with mature hardwood canopies.

INVENTORY NEEDS

Nonalluvial mineral wetlands are a fairly low priority for basic inventory at present. The recently completed Albemarle/Pamlico Estuarine Study natural area inventories examined the northeastern part of the state where most examples occur. Only a few more examples likely remain to be discovered in more inaccessible areas. There is, however, a need for more detailed inventory on high priority sites to support preserve design and protection efforts. Inventory of invertebrates associated with Wet Marl Forests is needed.

MANAGEMENT ISSUES

Hydrology: Nonalluvial mineral wetland communities are strongly dependent on hydrology. Because they depend on surface flow and poor drainage, they can be affected by ditches on adjacent lands as well as on the site itself. Long term protection of high quality remnants may require blocking of ditches.

Fire: These communities generally are not very flammable and probably did not naturally burn very often. Some examples, especially mixed canopy Nonriverine Swamp Forests transitional to pocosins, may have been subject to rare catastrophic fires that regenerated the canopy. It has been suggested that some Nonriverine Swamp Forests may actually represent Peatland Atlantic White Cedar Forest communities which were prevented from burning or which did not regenerate to white cedar after cutting. Burning in these areas might restore them to white cedar dominance. More understanding of the fire dynamics of these communities and how they related to the adjacent flammable pocosins is needed.

Fragmentation: These communities naturally occurred in large blocks. Large areas and freedom from edge effects may be needed for some component species, especially animals. Small remnants may not be able to support these species. Attention to forested corridors and connections to other natural areas may help reduce this effect.

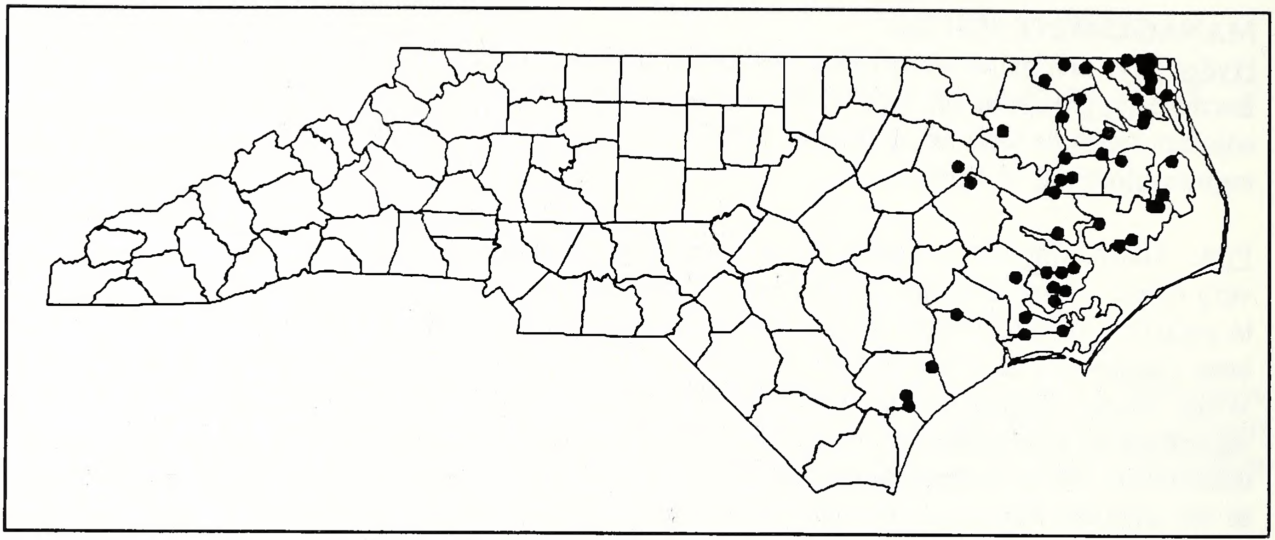
Exotic Species: Invasive exotic species, especially Japanese honeysuckle and Chinese privet, have become established in many examples of these communities. Where dense, they displace the natural herbs and shrubs and may affect tree regeneration. The factors affecting invasion are not known, but edge effects, fragmentation, and canopy opening by logging may be important factors.

LONG TERM GOALS

Because of their rarity and large decline in acreage, nonalluvial mineral wetlands are among the highest priorities for protection action. Protection is recommended for all high quality remnants of these communities. Somewhat degraded maple-gum dominated Nonriverine Swamp Forests often provide important wildlife habitat, and protection of some of them may be warranted as well.

TWO YEAR PLAN

In 1993-1995, the Natural Heritage Program will encourage further protection on the best examples of these endangered communities. Followup inventory, preserve design, landowner contact, and registry will be done as needed.



Recorded Occurrences of Coastal Plain Nonalluvial Mineral Wetlands

PEATLAND POCOSINS

COMMUNITY TYPES

Low Pocosin
High Pocosin
Pond Pine Woodland
Peatland Atlantic White Cedar Forest
Bay Forest

GENERAL DESCRIPTION

Peatlands occur on nearly flat, poorly drained areas of the outer Coastal Plain and in large shallow depressions such as Carolina bays. Peat deposits develop where the soil is saturated for long enough periods that organic matter cannot completely decompose. Once peat has developed, it acts as a sponge, raising water levels in the soil and making the site wetter. Without decomposition, plant nutrients are tied up in organic matter and the soil is extremely infertile and acidic. Without the overland flooding that contributes nutrients to river systems, nutrients in peatlands can be limited to only the small amount that comes in rain water.

The five natural community types are determined by variation in wetness, depth of peat, and fire dynamics. Low Pocosins occur on the deepest peats, in the interior of large domed peatlands, and in the largest peat-filled Carolina bays. These, the wettest, most nutrient-poor sites, support only low shrubs and scattered stunted pond pine trees. Often, beds of pitcher plants and sphagnum moss cover large areas, and bog species such as cranberries occasionally occur. High Pocosins occur in somewhat less deep peats. The shrubs, up to six or eight feet tall and impenetrably dense, are generally laced together with greenbriars and punctuated with sparse, stunted pond pines. Pond Pine Woodlands occur on shallow organic deposits on the edge of peatlands and in shallow swales and bays, where tree roots can grow through the thin organic layer to reach mineral soil below. Pond pines are tall and often fairly dense, and the shrub layer is tall and usually very thick. In some Pond Pine Woodlands the dense shrub layer is replaced by canebrake.

Peatland Atlantic White Cedar Forests occur in sites similar to Pond Pine Woodland or High Pocosin, but are dominated by Atlantic white cedar instead of pond pine. Bay Forests may occur in similar sites, but they are usually associated with the heads of creeks draining out of the peatlands. They have a canopy dominated by evergreen hardwood trees -- loblolly bay, sweet bay, and red bay.

Fire is a major natural force in peatland communities. While peatlands are too wet to burn most of the time, during droughts intense fires can occur. Fires usually burn the dense shrubs to the ground, and may burn holes in the peat soil itself. While appearing destructive, such fires act as a renewing force, releasing nutrients that stimulate seed germination and quick regrowth from root sprouts, regenerating the plant communities. Pond pines can resprout not only from roots but from charred trunks as well. Atlantic white cedar is killed by fire but is able to reestablish in dense stands from seed accumulated in the peat. Atlantic White Cedar Forests occur only where a fire has occurred under the proper conditions, and once established, can last for a century or more. In Pond Pine Woodlands, fire may have been more frequent and less intense, favoring dominance of cane over broadleaf shrubs.

RARE SPECIES

Peatland pocosins are low in numbers of rare species. A few rare plants, such as spoon flower (Peltandra sagittifolia) and cranberry (Vaccinium macrocarpon) occur. The endangered rough-leaf loosestrife (Lysimachia asperulifolia) can also occur in openings in pocosins. The borders of pocosins, where they adjoin wet pine savannas, often are extremely diverse and harbor a large number of rare plant species that are more typically identified with savannas. Large peatland pocosins are the largest, wildest natural lands in the Coastal Plain. As such, they provide habitat for wide-ranging animals that are sensitive to human disturbance, including black bears.

EXAMPLES

Holly Shelter Game Land, Pender County
Croatan National Forest, Jones, Craven and Carteret counties
Alligator River National Wildlife Refuge, Dare County
Pocosin Lakes National Wildlife Refuge, Washington, Hyde and Tyrrell counties
Bushy Lake State Natural Area, Cumberland County
Jones Lake State Park, Bladen County
Bladen Lakes State Forest, Bladen County
Green Swamp, Brunswick County

STATEWIDE STATUS

North Carolina has the world's majority of peatland pocosin acreage. While the deep peats escaped early clearing for agriculture, many peatlands have been severely altered more recently by draining and clearing for large farming ventures and for timber and pulpwood plantations. Peatland Atlantic White Cedar Forests continue to be heavily cut and generally do not regenerate after cutting. They are the rarest and most threatened of the peatland communities. Several remnants are protected on public and Natural Conservancy lands, but more protected examples are needed. Low Pocosins are fairly rare, though examples are sometimes very large. Several examples are publicly owned, and several other examples are formally protected. High Pocosins and Pond Pine Woodlands are more common, and a number of examples are protected. As with most communities, however, truly high quality examples with mature canopy and natural fire dynamics are rare. Less is known about the status of Bay Forests. Few examples are recorded, but they are believed to be overlooked, rather than very rare.

INVENTORY NEEDS

Overall, peatland pocosins are a fairly low priority for inventory. The locations of large peatlands are well known. Many smaller examples of Pond Pine Woodland, perhaps of high quality, undoubtedly remain to be discovered. Because of the difficulty of working in pocosins, many known examples are very poorly explored and their condition, composition, and patterns are not known. Pocosins are not known to support many rare species, but little work has been done in most. Invertebrates are particularly poorly known, although a number of rare moth species are believed to be associated with pocosin communities. Much research is still needed to understand the ecological nature and dynamics of these communities.

MANAGEMENT ISSUES

Fire: While not requiring burning as frequently as longleaf pine communities, pocosins appear to depend ultimately on fire to function in a natural way. Fires in pocosins are very intense and difficult to control. Much work is needed in developing and applying methods of prescribed burning in these communities.

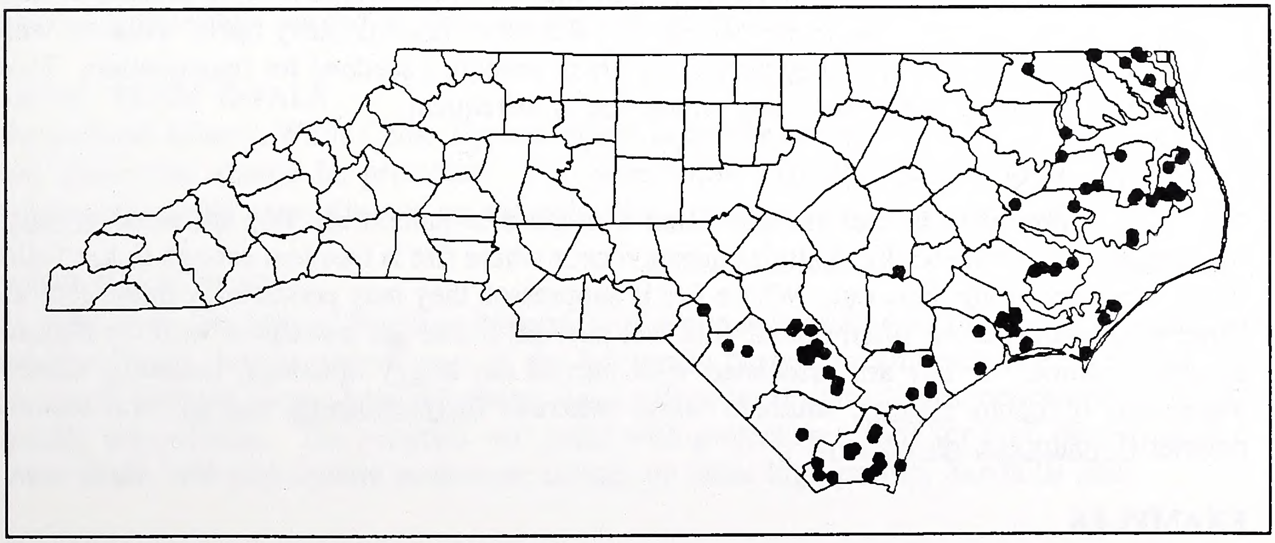
Hydrology: Many peatlands have some ditches in them which alter hydrology. Peatlands depend on surface flow of water, and they function as complex hydrological systems. Drainage of part of a peatland is likely to affect other parts. Some attempts at restoration of natural hydrology are being attempted in ditched pocosins on public lands.

LONG TERM GOALS

Because of their rarity and concentration in North Carolina, all remaining large peatlands deep enough to support Low Pocosin warrant protection. More high quality examples of shallow peatlands should also be protected. Because of their rarity and threat, Peatland Atlantic White Cedar Forests and mature burned Pond Pine Woodlands are in particular need of more protected examples. Development and implementation of prescribed burning is needed.

TWO YEAR PLAN

In 1993-1995, Natural Heritage Program inventories in Brunswick and Columbus counties will search for high quality peatland communities as well as other communities. A project to map the natural communities of Croatan National Forest, with which the program is cooperating, will provide new detailed information on one of the largest pocosin complexes. A probable inventory on Dare Bombing Range will investigate large parts of another of the major peatlands.



Recorded Occurrences of Peatland Pocosins

STREAMHEAD POCOSINS

COMMUNITY TYPES

Streamhead Pocosin
Streamhead Atlantic White Cedar Forest

GENERAL DESCRIPTION

These communities have vegetation fairly similar to that in peatland pocosins, but the physical setting is very different. They occur in ravines in dissected, sandy Coastal Plain terrain. The soils, kept essentially permanently saturated primarily by acidic seepage from adjacent sandhills, are mucky, very acidic, and infertile. In the Streamhead Pocosin community type, an open tree canopy dominated by pond pine is usually present. Some red maple, swamp black gum, tulip poplar, and sourwood is often present. Red bay and sweetbay often form an open understory. As in other pocosins, the shrub layer is very dense and is frequently tangled with laurel-leaf greenbriar. Herbs are nearly absent except in the edge (ecotone) with neighboring sandhill communities. These ecotones often support a high diversity of herb and shrub species, including many rare ones.

Diverse herb patches also develop in places where very intense fire burns the shrubs down, creating boggy openings. Fire spreading from adjacent sandhills probably frequently burned through streamheads under natural conditions. All of the shrubs readily resprout after fire. In the few remaining places where fire is frequent, Streamhead Pocosins are patchy, with some parts being dense shrub thickets, some being savanna-like with sparse trees over ferns, and some being treeless canebrakes. Streamhead Atlantic White Cedar Forests are dominated by Atlantic white cedar, though any of the species of the Streamhead Pocosin type may be present in small numbers. The canopy is often dense enough that the shrub layer is fairly open. Atlantic white cedars are sensitive to fire, but they depend on fire to prepare a seedbed for regeneration. These communities probably can persist only where fire is infrequent.

RARE SPECIES

A number of rare plant species are associated with these communities. Bog spicebush (Lindera subcoriacea) and white wicky (Kalmia cuneata) occur where fire is frequent enough to keep taller shrubs from crowding them out. Where fire is suppressed they may persist only in the ecotone. Other rare plant species, often shared with wet pine savannas, are associated with the pocosin-sandhill ecotone. A few are associated with burned out boggy openings, including Coker's bugleweed (Lycopus cokeri), southern white beakrush (Rhynchospora macra), and resinous boneset (Eupatorium resinosum).

EXAMPLES

Fort Bragg, Hoke County
Sandhills Game Land, Richmond and Scotland counties
Overhills Estate, Hoke, Cumberland and Harnett counties
Weymouth Woods State Natural Area, Moore County

STATEWIDE STATUS

Streamhead Pocosins are abundant in the Sandhills region but rare in the rest of the Coastal Plain. Most examples have escaped direct destruction, but most have been degraded by fire suppression, logging, and sediment inflow. A number of fairly good examples are in protected areas, usually incidentally to protecting other features. Frequently burned examples are rare. The common practice of plowing fire lines in the pocosin-sandhill ecotone has badly damaged the most diverse part of many examples. Streamhead Atlantic White Cedar Forests are rare even in the Sandhills. Only four examples are protected.

INVENTORY NEEDS

Streamhead Pocosins are a relatively low priority for inventory. They should be inventoried incidentally with other communities whenever possible. Because of their rarity, Streamhead Atlantic White Cedar Forests are a high priority for inventory.

MANAGEMENT ISSUES

Fire: These communities were frequently exposed to fire under natural conditions, though they may not always have burned. Fires in adjacent sandhills should be allowed to carry into streamheads. Fires in the pocosin vegetation, when conditions are dry enough for them to carry, are very intense; however, the narrow shape of most streamheads makes burning safer and easier than in peatland pocosins.

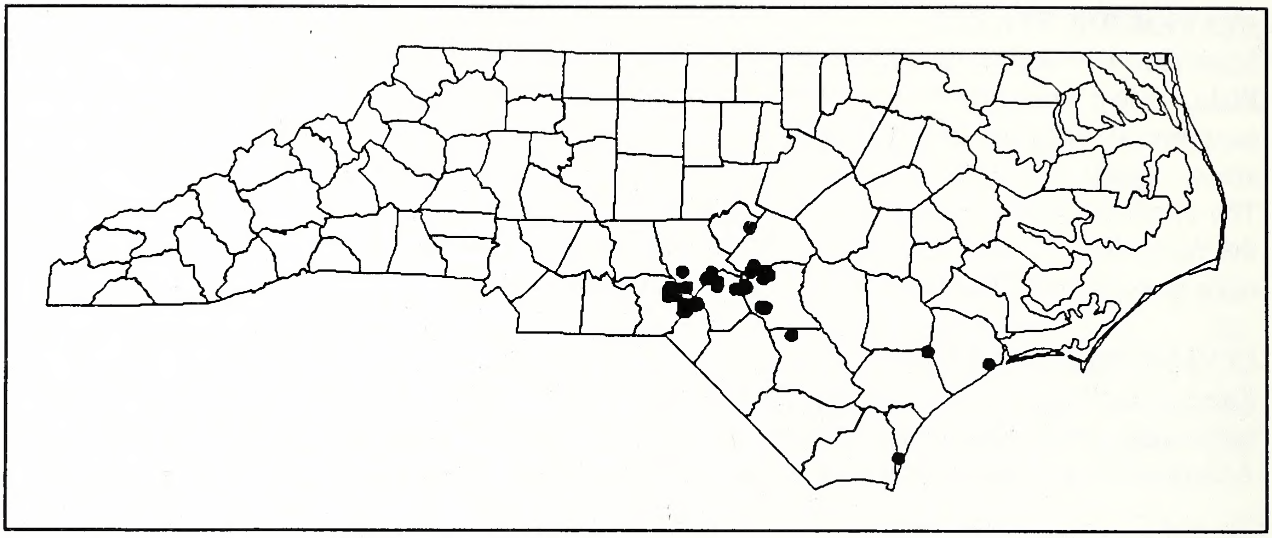
Sediment: Streamheads are bordered by slopes which may be fairly steep. Disturbance of uplands above, or areas upstream, causes erosion and movement of sediment into streamheads. Sediment input is extremely damaging to the communities, causing weedy species such as red maple to invade and many pocosin species, including pond pine, to disappear. Good erosion control is especially needed at road crossings of streamheads.

LONG TERM GOALS

Streamhead Atlantic White Cedar Forests appear to be rare enough that most good examples that are discovered should be protected. For Streamhead Pocosins, protection should focus on frequently burned examples and on examples that are part of large natural complexes.

TWO YEAR PLAN

In 1993-1995, the Natural Heritage Program will continue to assist with the inventory under way on Fort Bragg, which covers most of the frequently burned streamheads likely to exist. An inventory planned for the Sandhills Game Land will cover the next largest concentration of good quality streamheads. The program will assist with protection efforts for high priority sites on these lands, and may initiate landowner contact on other high priority Sandhills sites.



Recorded Occurrences of Streamhead Pocosins

WET PINE SAVANNAS

COMMUNITY TYPES

Pine Savanna
Sandhill Seep
Wet Pine Flatwoods

GENERAL DESCRIPTION

The communities in this theme are Coastal Plain mineral soil wetlands that under natural conditions were frequently burned. With frequent fire they have an open canopy dominated by longleaf or pond pine over a grassy herb layer. Shrubs are short and sparse with frequent fire, but become dense if fire is suppressed for more than a couple of years.

The Pine Savanna community type occurs in flat areas that are saturated or even slightly flooded during the wetter parts of the year. The herb layer is dominated by grasses and sedges, most typically wiregrass, Carolina dropseed, toothache grass, muhly, and various beakrushes. A variety of low shrubs may be present, but are low and open if the savanna is frequently burned. The herb layer usually contains many showy composites, orchids, and insectivorous plants. One of the most notable features of Pine Savanna communities is their tremendous plant diversity at small scales. Up to 52 species have been recorded in a single square meter, and up to 84 species in a 625 square meter area. These are among the highest diversity values in temperate North America. The limited study of insects suggests that at least some groups may also have high diversities.

Sandhill Seep communities occur on sloping seepage areas, where the wettest parts are essentially permanently saturated. They share many species with the Pine Savanna type but are more heterogeneous and generally more bog-like in character. Individual seeps are often strongly zoned in response to varying wetness. Tall evergreen pocosin shrubs, low shrubs, cane, cinnamon fern, sedges, grasses, and peat moss may dominate in different patches. In frequently burned seeps, grassy and sedgy areas can have a high diversity of plants, rivalling the Pine Savannas in species richness at small scales.

Wet Pine Flatwoods communities usually occur in flat areas, though sloping areas are possible. They resemble Pine Savannas in general structure, with an open pine canopy over a grassy ground cover with low shrubs. Wiregrass is always the dominant herb. Shrubs become dense if fire is excluded. Unlike Pine Savannas, the herb diversity is low. In many cases, only one to five species may be present in a square meter. The relationship between Wet Pine Flatwoods and Pine Savanna communities is not well known, but wetness and soil fertility appear to be important factors.

Each of the community types includes much variation. Several variants are recognized in each type, and more are likely to be recognized with further study.

RARE SPECIES

Pine Savanna and Sandhill Seep communities support the largest number of rare plant species of any communities in the state. They include a number of endemic species with very limited range, including some extremely rare ones such as Cooley's meadowrue (Thalictrum cooleyi), savanna indigo-bush (Amorpha georgiana var. confusa), and golden sedge (Carex sp. 1).Rare species found in a slightly greater number of sites include rough-leaf loosestrife (Lysimachia asperulifolia), Venus flytrap (Dionaea muscipula), and Carolina goldenrod (Solidago pulchra). Several rare vertebrates are also associated with these communities, including the red-cockaded woodpecker (Picoides borealis), Bachman's sparrow (Aimophila aestivalis), eastern diamondback rattlesnake (Crotalus adamanteus), and the mimic glass lizard (Ophisaurus mimicusu). A number of rare insects, such as arogos skipper (Atrytone aragos), byssus skipper (Problema bulenta), sundew cutworm moth (Hemipachnobia subporphyrea subporphyrea), Carter's noctuid moth (Spartiniphaga carterae), and Buchholz's dart moth (Agrotis buchholzi) are known to be associated with savannas, and many more are likely to occur in the less studied insect groups.

Wet Pine Flatwoods are generally lower in rare species, but red-cockaded woodpecker, Bachman's sparrow, and other rare vertebrates occur in them. The edge or ecotone between Wet Pine Flatwoods and pocosin communities often contains some of the rare savanna plants occurring in a narrow zone.

EXAMPLES

Green Swamp, Brunswick County
Myrtle Head Savanna, Brunswick County
Lanier Quarry Savanna, Pender County
Old Dock Savanna, Columbus County
Millis Road Savanna, Croatan National Forest, Carteret County
Pringle Road Bay Rims, Croatan National Forest, Carteret County
Angola Creek Flatwoods, Pender County
Jones Lake State Park, Bladen County
Carolina Beach State Park, New Hanover County
Boiling Spring Lakes Wetland Complex, Brunswick County
Fort Bragg Military Reservation, Hoke County
Still Lane Seepage Slopes, Sandhills Game Land, Scotland County
Scotland Lane Annual Burn, Sandhills Game Land, Scotland County

STATEWIDE STATUS

Pine Savannas and Wet Pine Flatwoods were once abundant, covering vast areas in the lower, wetter parts of the Coastal Plain. This acreage has been drastically reduced by draining, clearing, conversion to pine plantations, and development. Fire suppression has led to the degradation and loss of other examples. These once-common communities have been reduced to scattered, mostly fairly small remnants. Logging, conversion, and development continue to eliminate many of the remnants. Pine Savannas are now rare. Several high quality examples are protected on Nature Conservancy preserves and public lands, but the tremendous diversity within the type is far from adequately represented or protected. Wet Pine Flatwoods are less rare but are uncommon and declining. A number of examples are protected in Registered

Natural Heritage Areas on public lands, but they do not represent adequate protection for the diversity of variants. Sandhill Seeps are inherently of limited area but were once widespread in the Sandhills region. Good quality examples are now very rare. A few good quality examples, some regularly burned, are protected on the Sandhills Game Land. Most of the good examples are on Fort Bragg, some in impact areas where they are burned very frequently. They have no protective designation.

INVENTORY NEEDS

A comprehensive inventory focused on longleaf pine communities is nearly completed, and will provide a good outline of remaining sites. Many of the sites are not adequately explored, however, and much more detailed work is needed. Ecological research is needed to clarify the relationships between the types and to better define the many variants within the types. A survey of insects associated with these communities is currently being completed.

MANAGEMENT ISSUES

Fire: All of these communities are strongly dependent on frequent fire. Natural structure and diversity of Pine Savannas and Sandhill Seeps begins to decline after only a few years without burning. The natural fire frequency has been estimated to have been every three to five years. Several decades without fire may lead to permanent loss or degradation of the community. Wet Pine Flatwoods decline slightly more slowly, but ultimately suffer the same fate. Much research has been done on the importance of fire and the details of how best to apply fire in these communities. The season of burning is important. Most natural fires were in the early growing season, and species are best adapted for fire at this time. Winter burning, the traditional time for most prescribed burns, is less beneficial. The size of land units burned in a given season is also important. Some insect species are not adapted to survive fire directly, but instead persist by recolonizing burned areas from adjacent unburned areas.

Fragmentation: As with other communities that were once widespread, fragmentation may be an important problem, especially for animals. Red-cockaded woodpeckers, for example, need a fairly large area near their colonies for foraging. Fragmentation may be an especially important problem for insects, many of which apparently do not survive fire but depend on recolonizing recently burned areas. While they depend on the habitat created by fire, they also depend on nearby unburned patches to provide a source for recolonization. With many examples now small and isolated, it is important that prescribed burning not cover an entire savanna patch at one time. More research is needed into the best ways to mitigate the effects of fragmentation.

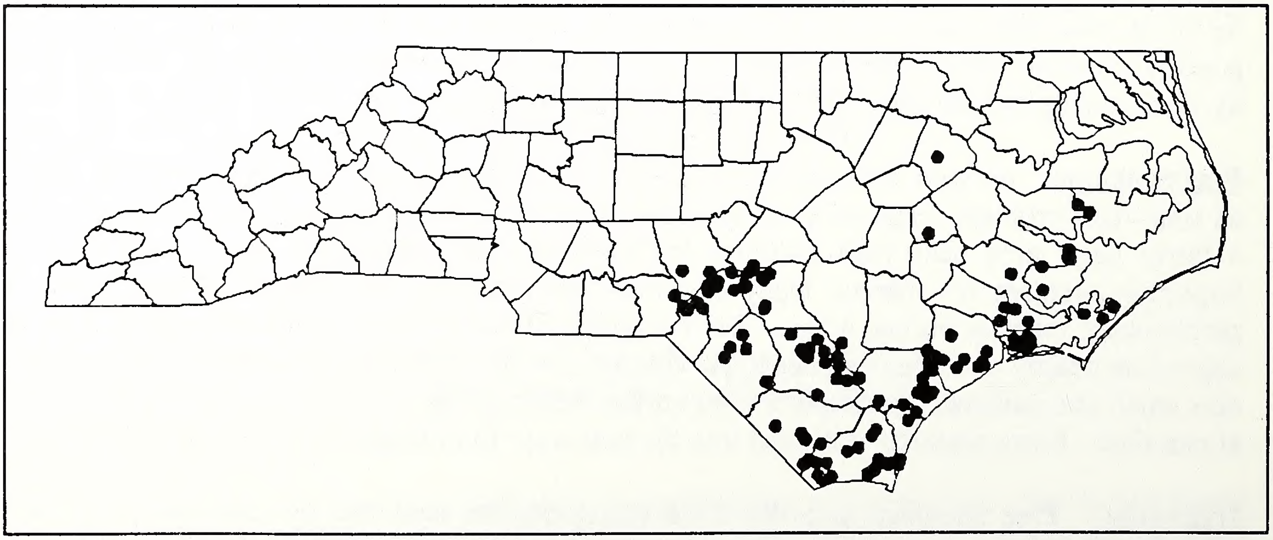
Hydrology: Pine Savannas and Wet Pine Flatwoods are kept wet by seasonally high water tables. These communities are easily drained by ditching and may be affected by ditches on adjacent areas. With altered hydrology, they are invaded by more upland plants. It is unknown how quickly community degradation takes place after the hydrology is altered, but it is clearly much faster in the absence of fire.

LONG TERM GOALS

More examples of all community types need to be protected. Given their rarity, all high quality, frequently burned examples of Pine Savanna, and most examples of Sandhill Seep and Wet Pine Flatwoods, should be protected. Examples should be protected to represent the variation in communities and to represent the geographic range. Careful management, with scientifically designed prescribed burning programs, should be applied on all protected areas. Widespread application of appropriate prescribed burning would allow improvement of additional degraded examples, and would provide habitat for many of the species associated with these communities.

TWO YEAR PLAN

During 1993-1995, the report of the inventory of longleaf pine communities will be completed and sites prioritized for protection. An inventory of Brunswick and Columbus counties, continued inventory on Camp Lejeune Marine Corps Base, and assistance with vegetation mapping on Croatan National Forest will provide additional detailed information on some poorly known sites. Participation with the North Carolina Vegetation Survey will provide basic scientific information to help clarify patterns of variation in these communities. The Natural Heritage Program will initiate or continue landowner contact on several high priority sites. The program will assist with protection efforts of other organizations.



Recorded Occurrences of Wet Pine Savannas

COASTAL PLAIN DEPRESSION COMMUNITIES

COMMUNITY TYPES

Vernal Pool
Cypress Savanna
Small Depression Pond
Small Depression Pocosin
Interdune Pond

GENERAL DESCRIPTION

The natural communities in this theme occur in various kinds of small basins in Coastal Plain uplands. The basins, which may be limesink depressions, Carolina bays, or swales between recent or older sand dunes, hold standing water for substantial parts of the year. Water levels usually fluctuate over the course of a season and also from year to year. The vegetation is often strongly zoned, with zones reflecting the variation in length of flooding (hydroperiod) along the sloping edges. Basin communities differ in overall hydroperiod, in soil, in slope, and in depth. Vegetation varies widely, perhaps partly because the isolation of individual basin clusters limits dispersal between them. Despite this, however, many plant species are shared with small depression communities from Massachusetts to Florida. The five community types included in this theme are very variable and contain many variants, though not all are yet defined.

The Interdune Pond type covers freshwater ponds on barrier islands. All are geologically young and potentially subject to sand dune movement or salt water flooding, as well as salt spray. Their vegetation varies from open water with aquatic plants such as water lilies, to deep water with sparse swamp black gum or bald cypress trees, to shallow water with beds of tall marsh species such as cattails, sawgrass, and southern wild rice.

Small Depression Ponds are the wettest of the mainland depression communities, occurring in basins that are essentially permanently flooded at least in the center. Aquatic plants such as water lilies are usually present in the middle, but zones of maidencane, rushes, sedges, and sometimes a sparse canopy of pond cypress or swamp black gum, occur around the edge of the water. A dense zone of pocosin shrubs, sometimes with pond pine, usually occurs around the outer edge of the basin.

Cypress Savannas occur in shallow basins that generally dry out, or at least lack standing water, by the end of the summer. The ground cover is dominated by a dense grassy herb layer of species such as Walter's sedge, maidencane, plume grass, spikerushes, and a variety of beakrushes. Showy flowers often are prominent when the water is gone. An open canopy of pond cypress is often present, though it is absent in the Depression Meadow Variant.

Vernal Pools occur in the shallowest basins, which dry up early in the summer. They combine wetland plants, such as centella, sundews, bladderworts, and Virginia chain fern, with plants more typical of uplands, such as little bluestem, switch grass, and panic grasses.

Small Depression Pocosins occur in small basins that are filled with organic deposits. The vegetation is a dense thicket of pocosin shrubs such as fetterbush, gallberries, titi, red bay, sweetbay magnolia, and highbush blueberries, often with a pond pine, red maple, or swamp black gum canopy. Laurel-leaf greenbriar may be common. These communities have much in common with the peatland and streamhead pocosins.

RARE SPECIES

Small Depression Ponds and Cypress Savannas support large numbers of rare plant species, including showy species such as West Indies meadow beauty (*Rhexia cubensis*) and awned meadow beauty (*Rhexia aristosa*), and numerous grasses and sedges, including pinebarren smokegrass (*Muhlenbergia torreyana*), Hirst's panic grass (*Dichanthelium* sp.1), coastal beakrush (*Rhynchospora pleiantha*), and Tracy's beakrush (*Rhynchospora tracyi*). The rare shrub pondspice (*Litsea aestivalis*) occurs in shrub-bordered ponds. Several plants of savannas and pocosin ecotones, such as Carolina goldenrod (*Solidago pulchra*) and Florida goober grass (*Amphicarpum muhlenbergianum*) may occur on the upland edge, where fires run into the shrubby edge zone. These communities provide important fish-free breeding habitat for amphibians, including rare ones such as the gopher frog (*Rana capito*) and tiger salamander (*Ambystoma tigrinum*). Nesting colonies of colonial water birds sometimes occur in the trees on the margins of these communities.

Vernal Pools and Small Depression Pocosins are generally low in rare species, though a few of the plants and animals of the wetter depression communities may sometimes occur in them. Interdune Ponds support only a few rare plant species, such as Carolina grasswort (*Lilaeopsis carolinensis*) and water violet (*Hottonia inflata*).

EXAMPLES

Carolina Beach State Park, New Hanover County
Patsy Pond Limesink Complex, Croatan National Forest, Carteret County
Camp Lejeune Marine Corps Base, Onslow County
Boiling Springs Lake Limesink Complex, Brunswick County
Bog Hole, Sandhills Game Land, Scotland County
McIntosh Bay Complex, Scotland County
Antioch Bay, Hoke County
State Line Prairie Bay, Scotland County
Pretty Pond Bay, Robeson County

STATEWIDE STATUS

All of these communities are rare in North Carolina and apparently throughout their ranges. Interdune Ponds are perhaps the rarest, with only nine sites known. Most examples are under protective designation and are on public lands. Cypress Savannas occur primarily in clay-based Carolina bays in a three-county area and in a cluster of limesinks on Camp Lejeune. While numerous in these areas, most examples have been degraded or destroyed. Several clay-based bays are protected on Nature Conservancy preserves. Small Depression Ponds are slightly more widespread. Large clusters occur in Brunswick and New Hanover counties and in the Camp Lejeune and Croatan National Forest area, and small clusters and single ponds occur elsewhere.

Several examples are protected as Registered Natural Heritage Areas on both public and private land, but these do not approach adequate representation of the type. The abundance of Vernal Pools and Small Depression Pocosins is poorly known. They are believed to be less rare, but they are usually overlooked. Only a handful of examples of either are known to be protected.

INVENTORY NEEDS

These communities are a relatively high priority for inventory throughout most of their range. Recent inventories in Croatan National Forest and Camp Lejeune have covered these areas well, but earlier inventories in other areas are now out of date. Many known sites have not been visited in ten years and are in need of checking, while many others are in need of more detailed inventory. Much information is needed on the natural dynamics of these complex communities in order to manage them well. Much more basic information is needed on the patterns of their variation to help improve classification.

MANAGEMENT ISSUES

Hydrology: Many of the shallower depression wetlands, such as Cypress Savannas and Vernal Pools, have been ditched in the past. Ditches vary in their effectiveness, but some have clearly altered the hydrology of sites. Depression wetlands occur most often in sandy uplands, and they are believed to be tied to the local water table, at least for parts of the year. They may be affected by heavy pumping of shallow wells as well as by drainage of adjacent lands. The hydrology of these systems is poorly known, and the importance of different artificial modifications and of variations in weather is not known. Many depression wetlands have been unusually dry in the last five years or more.

Fire: While flooded wetlands do not appear flammable, basin wetlands that dry out in the summer are subject to fire. Even permanent ponds may be affected on their margins by fires spreading from adjacent uplands. Fire appears to be very important for maintaining Cypress Savanna and Vernal Pool communities. Many unburned examples are rapidly being invaded by pines which will ultimately shade out the diverse herb layers. The recent low water levels have probably been encouraging invasion, and the interaction of fire and drought may be very important.

Isolation: While basin wetlands are very distinct from adjacent upland communities, they are linked in various ways. Natural fire dynamics in basins depends on the fire dynamics in the surrounding area. Amphibians breeding in the ponds spend their adult life in different habitats. Many basins are left intact but are surrounded by degraded or unprotected uplands. Providing intact or restored uplands and connections to larger blocks of different habitat may help ensure the viability of some species. Small depressions often occur in clusters, often of several community types that are determined by different hydroperiods. Connections between the separate communities should be provided.

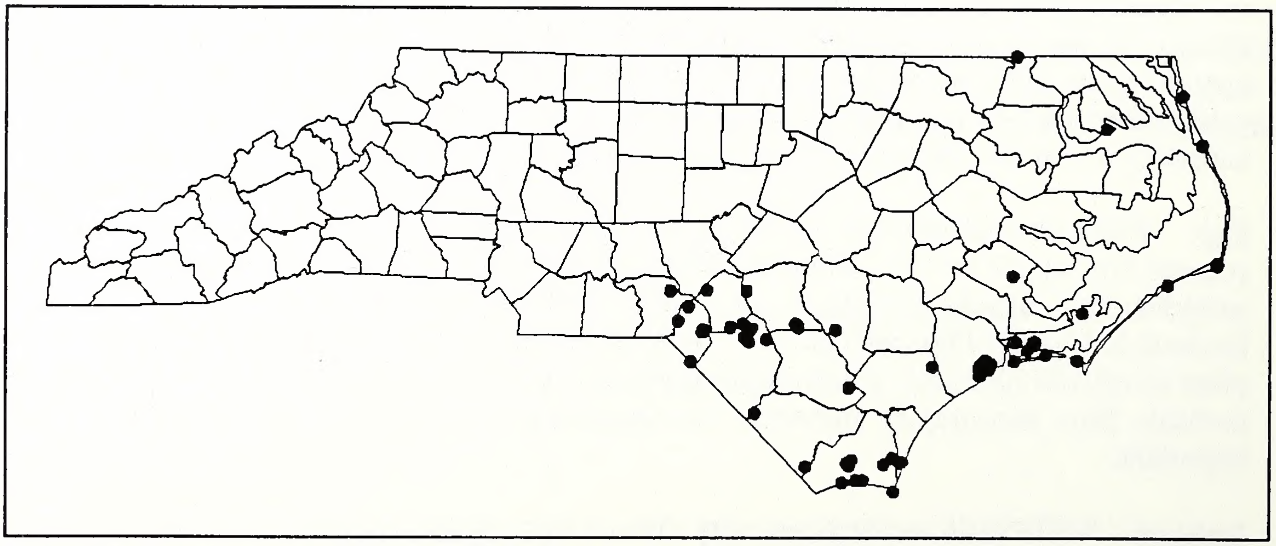
Water Quality: Most depressions have fairly small watersheds, but activities within these watersheds may affect water quality in the wetlands. Disturbance and sediment or chemical runoff due to development, agriculture, or forestry may be a concern in some places.

LONG TERM GOALS

More protected examples of all community types are needed. Given their rarity, all examples of Interdune Pond ideally should be protected. Protection efforts for the mainland community types should focus on the large and diverse clusters, high quality sites, and sites that represent the variation within the types. The diversity of these communities, their small size, and their limited usefulness for other purposes, should favor protection of many examples. Protected sites should include adequate upland habitat, and they should be managed with scientifically designed prescribed burning programs.

TWO YEAR PLAN

During 1993-1995, the Natural Heritage Program will conduct an inventory of Brunswick and Columbus counties, which will cover these communities in a part of the state where they are most abundantly concentrated. A followup inventory on Camp Lejeune will provide additional information for this major cluster. The program will pursue registry for several high priority sites and will encourage other protection efforts.



Recorded Occurrences of Coastal Plain Depression Communities

NATURAL LAKE COMMUNITIES

COMMUNITY TYPES

Natural Lake Shoreline
peatland lake aquatic community
calcareous lake aquatic community

GENERAL DESCRIPTION

Natural lakes occur only in the Coastal Plain part of North Carolina. Some lake basins are clearly Carolina bays, while others are depressions in peatlands that may have been created by deep peat burns or some other cause. Most are oval in shape, but a few are elongate and appear to be simply large wide places along creeks. Unvegetated aquatic natural communities have not yet been classified as have terrestrial communities. Nevertheless, at least two different communities can clearly be recognized, and these are given informal names above.

Most of the lakes in North Carolina are naturally very acidic. Most have tannin-stained water and are fairly low in productivity. Algae, mostly green algae or diatoms, are the primary plants, although a variety of aquatic vascular plants can be present. Fish numbers and diversity are low to very low. A variety of insects and other invertebrate animals spend some or all of their life cycles in the water. The one clearly different lake community is in Lake Waccamaw, where limestone outcrops on the lake shore give the water a neutral pH and a high calcium content. A much higher diversity of animals is present, including many more fish species and a diverse mollusk fauna. At least six mollusk species and several fish species are endemic to this one lake, or to the lake and the upper Waccamaw River system.

The Natural Lake Shoreline community type includes areas of emergent aquatic plants along lake margins and in wetland areas affected by lake hydrology. It is a heterogeneous type with many variants. Most shorelines are marshy, dominated by emergent plants such as maidencane. A few examples are well developed swamp forests, often dominated by sweetgum. The forested shorelines of several lakes are important nesting sites for colonial water birds such as herons.

RARE SPECIES

A high concentration of rare fish and mollusk species occurs in Lake Waccamaw. The Waccamaw darter (Etheostoma perlongum), the Waccamaw silverside (Menidia extensa), the Waccamaw spike (Elliptio waccamawensis) and several other species are endemic, meaning that they occur nowhere in the world except Lake Waccamaw and its immediate vicinity. The other lakes support few rare animals. A few rare aquatic plants occur in lakes or on marshy shorelines.

EXAMPLES

Lake Waccamaw, Columbus County
Jones Lake, Bladen County
Singletary Lake, Bladen County
Catfish Lake, Croatan National Forest, Craven County
Great Lake, Croatan National Forest, Craven County

Lake Phelps, Washington County
Whipping Creek, Swan Creek, and Milltail Lakes, Alligator River National Wildlife Refuge,
Dare County

STATEWIDE STATUS

Throughout the Coastal Plain of North Carolina, 22 natural lakes are known, though several have been heavily altered and no longer support natural aquatic communities. Most of the lakes themselves are publicly owned, but they vary greatly in the degree to which the shoreline is protected and in the amount of water quality protection provided. Several lakes, including Lake Waccamaw, White Lake, and Baytree Lake, have extensive development along the shoreline and are threatened by associated water pollution and alteration of hydrology. Several good examples of acidic lakes are surrounded by state park natural areas or by national forest wildernesses and are thus well protected.

INVENTORY NEEDS

The location and degree of direct alteration of the basin and shoreline are known for all of the lakes. Flora and fauna of lakes and their shorelines have been studied well for only a handful of lakes; most are poorly known.

MANAGEMENT NEEDS

Hydrology: The water level in lakes varies naturally with seasonal and long term rainfall, and with the nature of inflow and outflow. Many of the major lakes have artificial controls on their water levels in the form of dams or water control structures on the outlet. The natural water level fluctuation patterns and the needs of the aquatic communities are generally not well known, making appropriate natural management of water levels difficult. In many cases, some alteration of inflow hydrology has also occurred, in the form of drainage ditches or canals that either speed flow from swamps into the lake, or divert water away.

Water Quality: Artificial eutrophication, caused by excess nutrients, is a potential threat to many lakes. Pollution may come from sewage, lawns, agricultural runoff, or other sources in the watershed.

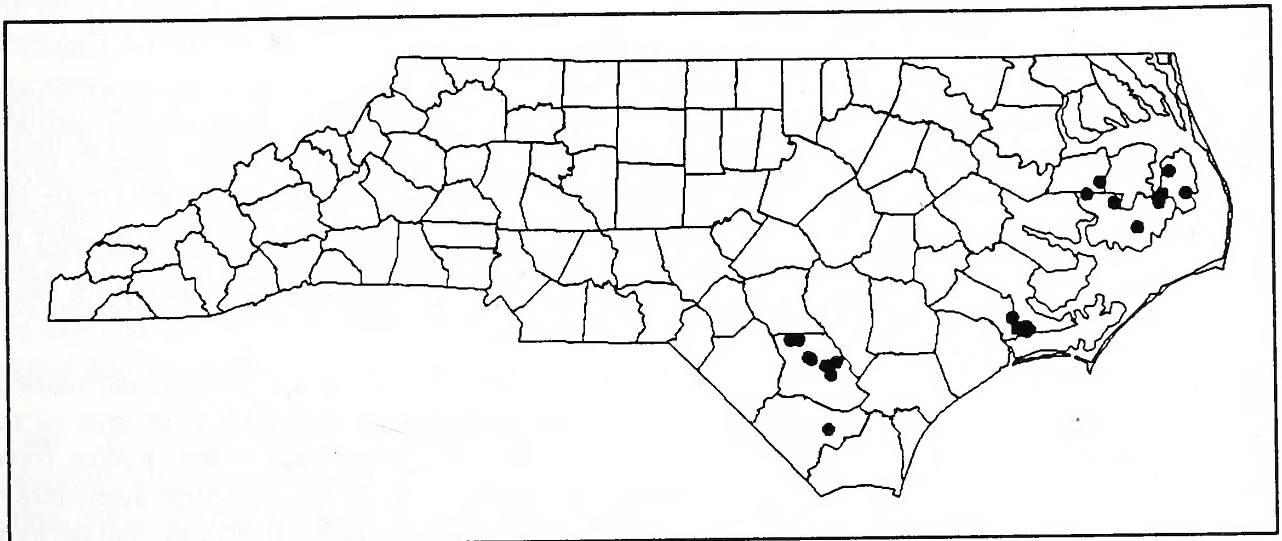
Exotic Species: Exotic species, introduced accidentally or sometimes deliberately, represent a potential threat to the aquatic communities of lakes. Both exotic animals and plants are a potential threat, though it is not known how serious the problem is at present. Invasion by nuisance aquatic weeds often leads to demands for control measures, such as herbicide application or introduction of grass carp, which are themselves destructive to native species.

LONG TERM GOALS

Natural lakes are rare enough and are of great enough public interest that protection should be considered for all examples. Effort should focus foremost on ensuring long term protection for publicly owned lakes from direct and indirect threats.

TWO YEAR PLAN

No further inventory efforts are planned by the Natural Heritage Program during 1993-1995. The Natural Heritage Program will encourage protection efforts by other agencies.



Recorded Occurrences of Natural Lake Communities

MARITIME WETLAND FORESTS

COMMUNITY TYPES

Maritime Swamp Forest
Maritime Shrub Swamp
Estuarine Fringe Loblolly Pine Forest

GENERAL DESCRIPTION

Maritime wetland forests occur in wet sites on barrier islands and near the sounds on the mainland. Maritime Swamp Forests and Maritime Shrub Swamps occur on barrier islands in dune swales which are sheltered from the most extreme salt spray and from seawater overwash. The soils are saturated for much of the year and may be flooded for substantial periods. Maritime Swamp Forests have a canopy of tall wetland trees which varies from place to place. Dominants include swamp black gum, red maple, ash, water oak, sweetgum, loblolly pine, and bald cypress. Maritime Shrub Swamps have a canopy of tall shrubs or small trees, usually red bay or swamp dogwood, which may be tangled together with vines. They are apparently wetter than Maritime Swamp Forests but also may be kept in shrub dominance by periodic disturbance.

Estuarine Fringe Loblolly Pine Forests occur on wet flats adjacent to salt or brackish marshes along the sounds. Loblolly pine is the dominant tree, and may be joined by sweetgum or red maple. There is often a fairly dense layer of shrubs and greenbriars which makes travel difficult. All of the dominant plants are species that occur in disturbed wet sites elsewhere in the Coastal Plain, but these communities appear to be of natural origin. It may be that periodic natural disturbances such as salt water intrusion prevent succession to hardwoods. It has been suggested that fire occurred naturally in these communities and that the natural aspect was open and grassy rather than shrubby.

RARE SPECIES

Maritime wetland forests have essentially no rare plant species associated with them. Little is known about the potential for rare animals.

EXAMPLES

Buxton Woods, Dare County
Nags Head Woods, Dare County
Theodore Roosevelt State Natural Area, Carteret County
Kitty Hawk Woods, Dare County
Swanquarter National Wildlife Refuge, Hyde County
Goose Creek State Park, Beaufort County

STATEWIDE STATUS

Maritime Swamp Forest and Maritime Shrub Swamp are both extremely rare in North Carolina and probably throughout their range. Only 12 of the former and four of the latter are known, and few, if any, more are likely to be discovered. Only a few examples are protected, some only partially. Unprotected examples on private land are highly threatened by the rapid development taking place on barrier islands. Wetland regulations offer some protection, but examples are frequently excavated, converted to ponds, fragmented by fill, or isolated within developed uplands. Estuarine Fringe Loblolly Pine Forests are apparently fairly common in the northern part of the state's coastal fringe, but almost no examples are protected.

INVENTORY NEEDS

Maritime wetland forests are a relatively low priority for inventory. The recently completed Albemarle/Pamlico Estuarine Study inventories examined most of the area where Estuarine Fringe Loblolly Pine Forests are likely to occur. The barrier islands were inventoried several years ago, so new Maritime Swamp Forest or Shrub Swamp sites are unlikely to be found. There is a need for monitoring and followup inventory on some of the sites.

MANAGEMENT ISSUES

Hydrology: Maritime swamps are apparently fed by both shallow ground water and accumulating rain water. They will be affected by drainage or blocking of drainage of any portion of the dune swales in which they occur. Pumping of shallow ground water, which lowers the water table for some distance around the wells, is likely to dry out the wetlands and alter the vegetation. Heavier pumping which allows salt water intrusion into the aquifer could be expected to have even more detrimental effects. Disturbance of uplands around the swamps could also be expected to alter hydrology.

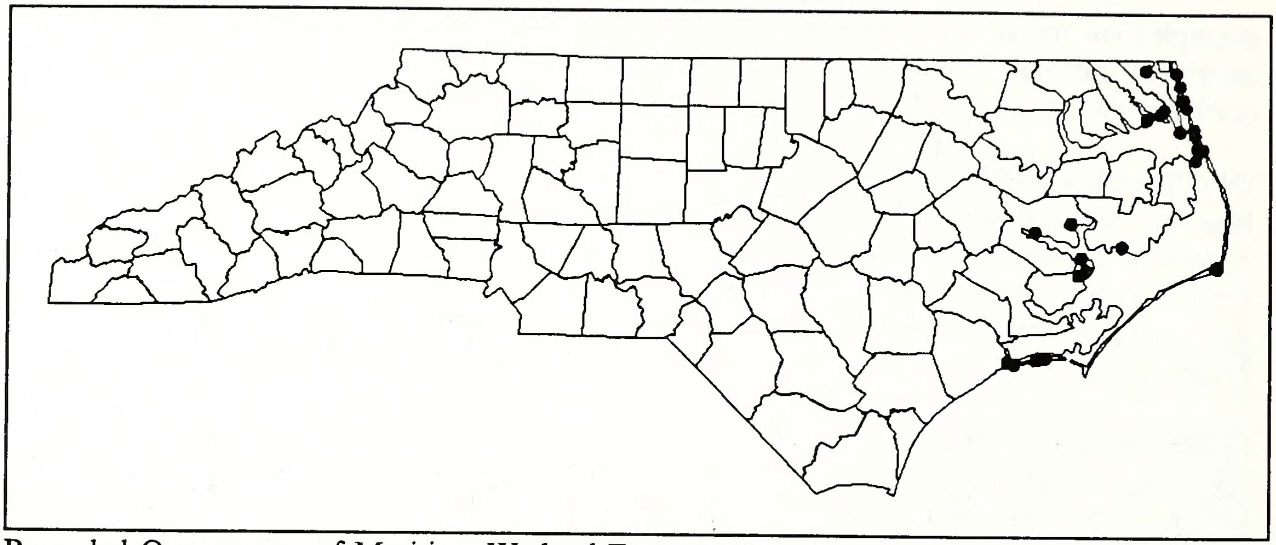
Fire: Estuarine Fringe Loblolly Pine Forests usually adjoin flammable communities and probably burned periodically under natural conditions. The dense shrubs and vines found in most examples may be an artifact of fire suppression. The one known example that has had fire is open and has a well-developed herb layer. Maritime Swamp Forests and Shrub Swamps probably did not burn.

LONG TERM GOALS

Because of their extreme rarity and variability, all remaining viable examples of Maritime Swamp Forest and Maritime Shrub Swamp ideally should be protected. High quality examples of Estuarine Fringe Loblolly Pine Forest should be protected, with emphasis on larger examples that are contiguous with other natural communities.

TWO YEAR PLAN

An inventory of moths, butterflies and other insects will be conducted in Goose Creek State Park and Nag's Head Woods during the next two years. No other Natural Heritage Program inventories are planned in areas likely to contain maritime wetland forest community types during 1993-1995. The program will continue to support protection efforts under way at a couple of sites, and will encourage protection of the other sites. Followup or more detailed inventory will be conducted if needed.



Recorded Occurrences of Maritime Wetland Forests

FRESHWATER TIDAL WETLANDS

COMMUNITY TYPES

Tidal Freshwater Marsh
Tidal Cypress--Gum Swamp

GENERAL DESCRIPTION

Freshwater tidal wetlands occur in sites where flooding occurs in response to lunar or wind tides, but where the water has less than the 0.5 parts per thousand salt content used to define fresh water. Tidal fresh waters occur in rivers, where freshwater flow keeps out salt water, and along the large sounds where distance from seawater inlets keeps the water fresh.

Tidal Cypress--Gum Swamps occupy vast areas at the mouths of large rivers and also occur at the mouths of smaller creeks and occasionally along the sound shoreline. They are dominated by swamp black gum, water tupelo, and bald cypress. Water ash and red maple are generally the only understory trees, and shrub and herb layers are generally sparse and low in diversity.

Tidal Freshwater Marshes occur in the lowermost parts of some tidal rivers and creeks and, more commonly, in large flats along the shorelines of freshwater sounds. The vegetation is generally strongly zoned and often very diverse in at least some zones. Common zone dominants include giant cordgrass, sawgrass, cattails, American threesquare, black needle rush, spike-sedges, southern wildrice, northern wildrice, arrowhead, marsh fern, and royal fern. Swamp rose, marsh mallow, and wax myrtle often form thickets. Some areas may have young stands of red maple, loblolly pine, or bald cypress. Two distinct variants are recognized, one with very slightly salty (oligohaline) water, the other completely fresh.

RARE SPECIES

Tidal Freshwater Marshes can support a number of rare plant species, including beaked spikerush (Eleocharis rostellata,) smooth sawgrass (Cladium mariscoides,) ribbed bishopweed (Ptilimnium costatum,) and Carolina grasswort (Lilaeopsis carolinensis.) Rare animal species are not well known. Several rare insects, including the rare skipper butterfly (Problema bulenta), occur in these communities. Rare plants almost never occur in Tidal Cypress--Gum Swamps. Animals such as black bear and alligator may occur.

EXAMPLES

North River/Deep Creek Marshes and Forest, Currituck County
Northeast Cape Fear River Floodplain, Pender County
Bull Neck Swamp, Washington County
Roanoke River Delta Islands, Bertie County
Bennetts Creek/Catherine Creek/Chowan Swamp State Natural Area, Gates County
Goose Creek State Park, Beaufort County
Northwest River Marsh Game Land, Currituck County
Tull Bay Marshes, Currituck County
Nellie Bell Pond, Marsh and Cedar Swamp, Currituck County

STATEWIDE STATUS

Freshwater tidal wetlands have generally escaped widespread destruction because of their wetness. Tidal Cypress--Gum Swamps are abundant in the outer Coastal Plain and often cover vast areas. Logging has affected almost all, however, and cypress often has not regenerated. Mature examples are rare. Only one large example, Roanoke River Delta Islands, is in public ownership. A couple of small examples are protected. Tidal Freshwater Marshes are uncommon, though extensive examples occur in limited regions such as the area around Currituck Sound and its tributaries and the mouth of the Cape Fear and Northeast Cape Fear rivers. Most are largely intact, but many have been altered by extensive mosquito ditching. Only a few small areas are protected.

INVENTORY NEEDS

Tidal Freshwater Marshes are a fairly high priority for Natural Heritage Program inventory. Tidal Cypress--Gum Swamps are a lower priority for inventory because they are more common and support few rare species. Many in the northern half of the state were examined in the recent Albemarle/Pamlico Estuarine Study inventories. Some sites are in need of followup inventory to support protection efforts. The southern freshwater tidal areas have had only sparse incidental survey and are poorly known. All areas are in need of animal study.

MANAGEMENT ISSUES

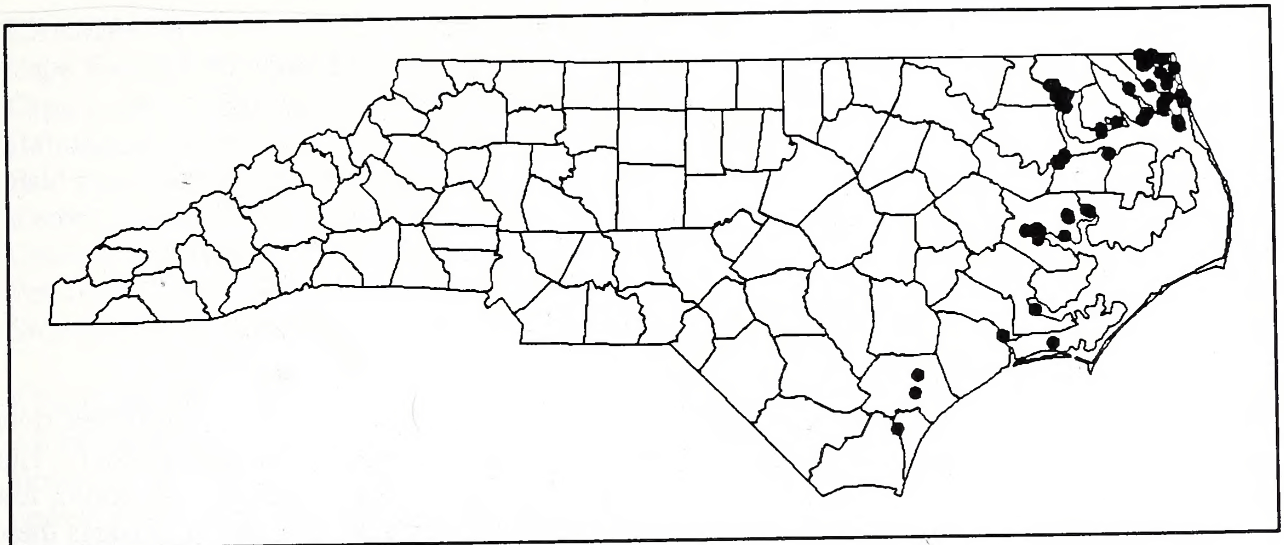
Fire: Tidal Freshwater Marshes apparently burned frequently under natural conditions. In the absence of fire, the large plants become more numerous and the high diversity of smaller plants is greatly reduced. Dead plant materials reduce overall productivity and reduce value to wildlife. Only a few marshes are currently burned. The thickets of invading trees may also result from lack of fire.

LONG TERM GOALS

Many more examples of both community types are in need of protection to adequately represent this theme. Protection should focus on the large complexes, but a variety of smaller sites, especially smaller sites contiguous to other natural lands, should also be protected to ensure geographic representation and representation of variation.

TWO YEAR PLAN

During 1993-1995, an inventory of Brunswick County will cover some of the extensive marshes in the southern part of the state. Additional Natural Heritage Program staff surveys may be conducted at some other sites. The program will undertake landowner contact for several sites and will assist with other protection efforts.



Recorded Occurrences of Freshwater Tidal Wetlands

ESTUARINE COMMUNITIES

COMMUNITY TYPES

Salt Marsh
Brackish Marsh
Salt Flat
Salt Shrub
estuarine open water communities

GENERAL DESCRIPTION

Estuarine communities are affected by tidal waters in and along the sounds and drowned river mouths. Salt Marshes occur where tides regularly flood the area with undiluted sea water. This environment of repeated flooding and exposure and high salt levels is habitable by only a few plant species, but is very fertile and productive. Saltmarsh cordgrass strongly dominates these communities, and only a few other vascular plants, such as salt grass and glasswort, occur. Algae may also be an important part of the plant productivity. The abundance of invertebrates such as mollusks and crustaceans indicates the transitional nature of these communities between terrestrial and marine systems.

Brackish Marshes occur in areas where the tidal waters are partly diluted by fresh water. They, too, are low in diversity of plants, with black needle rush usually strongly dominating vast areas. Salt meadow cordgrass, giant cordgrass, and sawgrass may be locally abundant, and a variety of smaller plants may occur in openings, especially if the marsh has been burned.

Salt Flats occur in fairly small areas of slight depression at the upper edge of salt or brackish marshes. Salty water floods these areas only occasionally. Once flooded, the water is trapped in the depression and evaporates, leaving salt concentrated in the soil. Vegetation is usually a sparse collection of extremely salt-tolerant plants such as salt grass and glasswort. The centers of the depressions may be completely barren.

Salt Shrub communities occur on the upper edge of salt and brackish marshes, where salt water rarely reaches or where salt is diluted by fresh water seepage. They are dominated by salt-tolerant shrubs, primarily marsh elder, sea oxeye, groundsel tree, and wax myrtle. Marsh herbs often occur in openings.

Estuarine open water communities are also included in this theme. Natural community types have not yet been defined for these underwater communities. They include both communities dominated by vascular plants such as eel grass and those dominated by sessile animals such as oysters. Other areas have no sessile organisms, and are dominated by mobile invertebrates or fish.

RARE SPECIES

Estuarine communities support very few known rare plants or animals. The combination of extreme environmental conditions, widespread occurrence of similar environments, and lack of isolation makes the occurrence of many unknown rare species unlikely.

EXAMPLES

Cape Hatteras National Seashore, Dare County
Cape Lookout National Seashore, Carteret County
Hammocks Beach State Park, Onslow County
Bald Head Island State Natural Area, Brunswick County
Rachel Carson National Estuarine Reserve, Carteret County
Cedar Island National Wildlife Refuge, Carteret County
Pea Island National Wildlife Refuge, Dare County
Swanquarter National Wildlife Refuge, Hyde County

STATEWIDE STATUS

All of these communities are considered common. Salt and Brackish Marshes cover vast areas along the coast and few have been destroyed. Substantial areas have been extensively ditched, however, and very few examples have been burned. Salt Shrub and Salt Flats cover less area but are widespread and have not generally been heavily disturbed. Numerous protected examples are found on public lands. Most are in the northern part of the state. The less extensive southern marshes are not well represented in protected areas, though intact examples are common and may not be threatened.

INVENTORY NEEDS

Estuarine communities in general are a low priority for Natural Heritage Program inventory. The Albemarle/Pamlico Estuarine Study inventories and extensive surveys on the Outer Banks have documented the major marsh areas in the northern half of the state. These communities are much less extensive in the southern part of the state and are less well known. More information is needed to develop a classification of estuarine open water communities. Inventory for good examples of these communities has not yet begun.

MANAGEMENT ISSUES

Fire: Brackish Marshes are believed to have burned naturally. In the absence of fire they become stagnant, with dense, dead needle rush reducing productivity and diversity. The other estuarine community types probably did not generally burn, though Salt Shrub may have been affected by fires in adjacent upland communities.

Water Quality: All of these communities are potentially affected by water pollution. The estuarine open water communities are particularly susceptible. Excess nutrients, excess sediment, bacteria, and toxic chemicals can come from rivers, shoreline developments, onshore land disturbances, or ships, and can have serious effects on the aquatic communities.

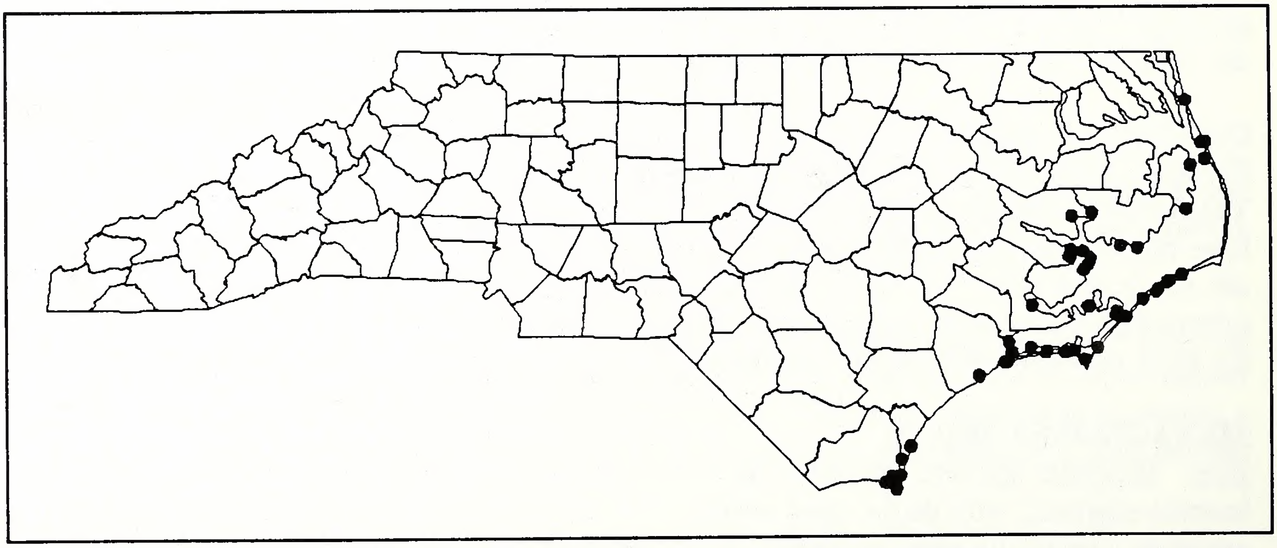
Water Flow: The balance of salt as well as nutrients is strongly affected by water flow. Artificial alterations to flow patterns, such as ditching, digging canals, and depositing dredge spoil, may damage communities by allowing penetration of more salt water than the resident species are adapted for, by allowing faster drying, or by ponding water and allowing salt to be concentrated by evaporation.

LONG TERM GOALS

While at least the vegetated communities are well represented in protected areas and only a few variants probably remain unprotected, the role these communities play in ecosystem function argues for protection of large portions of the existing examples. Management with fire in more of the Brackish Marshes and restoration of natural flow patterns in ditched examples are also long term goals.

TWO YEAR PLAN

In 1993-1995, an inventory of Brunswick County will cover some of the poorly known southern marshes. No other focused inventories of estuarine communities are planned in this period.



Recorded Occurrences of Estuarine Communities

LANDSCAPES

Much of the Natural Heritage Program's work is directed toward the inventory and protection of remaining populations of rare plant and animal species, as well as high quality natural communities. A species-oriented or community-oriented survey helps to determine how rare the species or community is, where it is located, and what the threats to it are. It also provides information needed to establish priorities for the protection and management of the species or community.

While providing critical information, a species-by-species, or even community-by-community, inventory of North Carolina will not prove successful unless combined with a more regional or landscape perspective. This is because the state's many species and communities interact with each other in complex ways. For example, mobile vertebrate animals, such as black bears, bobcats, and migratory birds, range over extensive areas, using a diversity of habitats for feeding, breeding, and resting. Freshwater mussels and fish depend on water quality, which is affected by land use in the entire watershed upstream from their populations.

Many natural communities experience periodic disturbance from causes such as fires, ice storms, tornados, hurricanes, floods and disease. Species inhabiting these areas are often adapted to a shifting mosaic of disturbed and undisturbed sites. Populations move around, recolonizing sites that are recently disturbed, intermediate, or stable and mature, depending on the habitat requirements of the species. In a landscape subject to change, a small preserved site centered on a current population cannot assure the long-term viability of a particular species. If the preserve experiences a natural disturbance, there may be no suitable site nearby for the population to recolonize. Clearly, many species and communities cannot be adequately protected without considering land use on a landscape scale.

The Natural Heritage Program addresses landscape level concerns in several ways. In the inventory of individual sites, the surroundings of the site and the connections to the larger landscape are considered. A site may be given increased priority for inventory and protection if it functions as a connection between other natural areas, and decreased priority if it is completely isolated. In addition, the Natural Heritage Program identifies and inventories large landscape areas within the state which contain clusters of related natural areas and which can be treated as functioning units. Different regions of North Carolina differ in their ecological resources and in the degree and nature of threats to those resources. For species and natural communities, inventory priorities are determined by rarity and threat. For landscape inventories, priority is similarly determined by regional ecological richness, by the likelihood of locating significant natural areas and rare species habitats, by the presence of large areas with relatively little alteration, and by the degree of threat to natural areas in the region. Individual sites within a high priority landscape are given increased priority because they are part of the larger unit.

Following is an overview of some of the regions and landscapes of North Carolina with highest priority for inventory.

SOUTHERN APPALACHIAN MOUNTAINS

The Southern Appalachians are ecologically very rich. They are the highest mountains in eastern North America, and they are by far the most significant mountain mass in eastern North America to escape glaciation in the Pleistocene. Over 400 species of plants and animals are found only in the Southern Appalachians. Moreover, the Mountain region of the state is the only part of the state where most of the landscape is in relatively natural vegetation. This is because steep slopes, relative inaccessability, and relatively recent settlement, compared to the Piedmont and Coastal Plain, have limited the intensity of landscape alteration in most of the region. The mountains are thus not only one of the most ecologically rich parts of the state, but also have received the least alteration to that ecological richness.

Subregions with particularly high ecological value include:

> Black Mountains/Craggy Mountains/North Fork Watershed/Big Ivy complex; Buncombe, Yancey and McDowell counties
>
> Great Smoky Mountains National Park; Swain and Haywood counties
>
> Roan Mountain Massif; Avery and Mitchell counties
>
> Grandfather Mountain; Avery, Watauga, and Caldwell counties
>
> The "amphibolite mountains" (Bluff Mountain, Phoenix Mountain, Mount Jefferson, Three Top Mountain, Long Hope Valley, Elk Knob, Snake Mountain, The Peak, Old Field Bald, Tater Hill, Rich Mountain); Ashe and Watauga counties
>
> Escarpment gorges (Toxaway, Eastatoe, Horsepasture, Thompson, Whitewater, Chatooga, Tuckaseegee, and Cullasaja) and granite domes; Transylvania, Jackson, and Macon counties
>
> Hickorynut Gorge/White Oak Mountain/Green River Gorge escarpment region; Polk, Rutherford, Buncombe, and Henderson counties
>
> Standing Indian, Chunky Gal, Upper Nantahala River, Buck Creek Barrens; Macon and Clay counties

Over the next two years, the Natural Heritage Program plans to conduct or complete county inventories for Buncombe, Henderson, Jackson, Madison, and Polk counties. Additional funding will be sought for other county inventories in the Mountain region. Inventories of U.S. Forest Service lands will be continued, and monitoring and management planning on the Roan Mountain Massif will be conducted in conjunction with other agencies. Additional funding may be sought for inventory work in the "amphibolite mountains" region, and in the Hickorynut Gorge area.

COASTAL PLAIN

The Coastal Plain is also very rich biologically, with many endemic and rare species of plants and animals. The southern half of the North Carolina Coastal Plain is one of the four major centers of biological diversity in the southeastern United States Coastal Plain, which extends from Long Island, New York, south to Florida and west to eastern Texas. The Coastal Plain is particularly rich in ecosystems and species adapted to highly acidic sandy and peaty soils and frequent fire. The large peat domes are nearly unique to North Carolina, and associated with them are highly diverse longleaf pine savannas and flatwoods.

Subregions with particularly high ecological value include:

> Bladen Lakes Carolina bay complex, and adjacent floodplains of the South, Black, and Cape Fear rivers; Bladen, Cumberland, Pender, Sampson counties
>
> Clay-based Carolina bays of Scotland, Hoke, Robeson, Cumberland, and Sampson counties
>
> Green Swamp, Juniper Creek, Lake Waccamaw, and Waccamaw River; Brunswick and Columbus counties
>
> Boiling Spring Lakes, Sunny Point; Brunswick County
>
> Holly Shelter Game Land and vicinity; Pender County
>
> Alligator River National Wildlife Refuge and Dare County Bombing Range; Dare, Hyde, and Tyrrell counties
>
> Pocosin Lakes National Wildlife Refuge/Lake Phelps/Lake Mattamuskeet; Tyrrell, Washington, and Hyde counties
>
> Camp LeJeune Marine Corps Base; Onslow County
>
> Croatan National Forest; Carteret, Jones, and Craven counties
>
> Outer Banks and barrier islands, Cape Hatteras and Cape Lookout National Seashores; Dare, Hyde, and Carteret counties
>
> Roanoke River bottomlands; Bertie, Martin, Halifax, and Northampton counties
>
> Currituck marshes; Currituck County

Over the next two years, the Natural Heritage Program will conduct or complete county inventories in Brunswick and Columbus counties. Funding will be sought for inventory work in clay-based Carolina bays and associated ecosystems. Detailed inventory work on Camp LeJuene Marine Corps Base will be continued. Additional county inventories and inventories

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of the Dare County Bombing Range and the Sunny Point Military Ocean Terminal will be high priorities for future funding.

SANDHILLS

The Sandhills, really a part of the Coastal Plain, are geomorphically and ecologically rather distinctive. An area with a large proportion of public land offers the potential for landscape scale conservation:

> Fort Bragg, Overhills, Sandhills Game Land; Cumberland, Harnett, Hoke, Moore, Richmond, Scotland counties

Over the next two years, the Natural Heritage Program will continue a cooperative inventory with The Nature Conservancy on Fort Bragg Military Reservation and nearby lands.

PIEDMONT

The Piedmont is overall the most heavily altered of the regions of North Carolina. The ecologically richest areas are generally associated with unusual geology, such as diabase glades and barrens, post oak-blackjack oak savannas, and granite flatrocks.

Areas with particularly high ecological value include:

> Franklin/Wake flatrock district; Franklin, Wake, and Granville counties
>
> Anson County flatrock district; Anson County
>
> Granville/Durham diabase sills; Granville and Durham counties
>
> Uwharrie National Forest and vicinity; Montgomery, Randolph, Davidson, Rowan, and Stanly counties
>
> Sauratown Mountains (Hanging Rock, Pilot Mountain, Sauratown Mountain); Stokes and Surry counties
>
> South Mountains; Burke, Rutherford, McDowell, Cleveland counties
>
> Pee Dee National Wildlife Refuge; Anson County

Over the next two years, the Natural Heritage Program will continue an ongoing inventory of the South Mountains area. County inventories in Rowan, Polk, Lee, Durham, Guilford, and Surry counties will be continued, and additional funding may be pursued for other Piedmont county inventories. An ongoing survey of Piedmont mafic rock communities will also be continued. High priority sites will be targeted for protection efforts.